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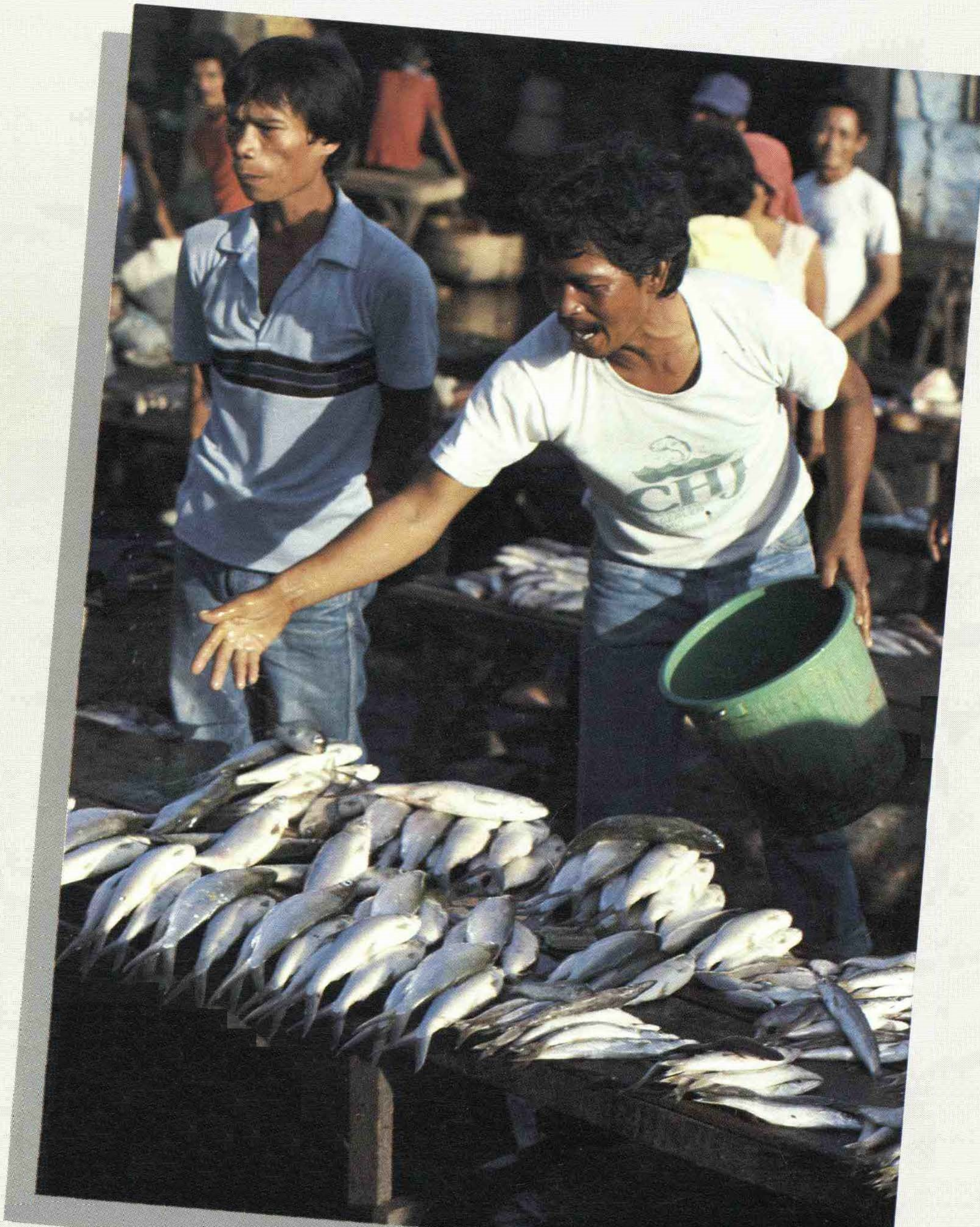
Small-Scale Fisheries in Asia:

Socioeconomic Analysis and Policy



Theodore Panayotou

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Socioeconomic Analysis and Policy

Editor: Theodore Panayotou

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Abstract

Because of the new ocean regime of extended fisheries jurisdictions, governments of developing countries in Asia, and elsewhere, face a unique opportunity for upgrading their depressed coastal fisheries to take advantage of their enlarged resource base. This volume is a partial response to the resulting need for a better understanding of the constraints and opportunities facing small-scale fisheries. It contains 23 papers on small-scale capture and culture fisheries from five Asian countries — Bangladesh, Malaysia, Philippines, Sri Lanka, and Thailand — based on original field research sponsored by the International Development Research Centre. Among the subjects covered are socioeconomic conditions, productivity and economic efficiency, cost structure and profitability, marketing, social and institutional constraints, and government programs. The authors conclude that the scope for further fisheries development is strictly limited by the size of the resource. The success of any fisheries development scheme will be determined by the effectiveness of management schemes taken concurrently with development of controls on entry into the fishery. Improvements in resource productivity and in living standards could come about only if fishery-related interventions are complemented by rural development on a broader resource base.

Résumé

Le nouveau droit de la mer, qui étend la juridiction dans le domaine de la pêche, offre aux gouvernements des pays en développement, d'Asie et d'autres régions du monde, la chance unique de relancer leur pêche côtière peu productive en tirant profit d'un territoire de pêche élargi. Cet ouvrage apporte une réponse partielle aux questions qui se posent, conséquemment, face aux obstacles comme aux possibilités qu'offre la pêche artisanale. Les 23 communications sur la pêche et l'élevage à petite échelle proviennent de cinq pays asiatiques : Bangladesh, Malaisie, Philippines, Sri Lanka et Thaïlande. Elles sont le fruit de recherches originales menées sur le terrain et subventionnées par le Centre de recherches pour le développement international. Notons, parmi les sujets abordés, les conditions socio-économiques, la productivité et l'efficacité économique, la structure des coûts et la rentabilité, la commercialisation, les obstacles d'ordre social et institutionnel, et les programmes gouvernementaux. Les auteurs concluent que tout espoir de développer les pêches est lié directement aux dimensions des territoires. Le succès de tout programme de développement des pêches dépend de l'efficacité des plans de gestion et, concurremment, de l'application de mesures de contrôle réglant l'entrée sur le territoire. Toute amélioration de la productivité comme du niveau de vie ne peut se produire que si les politiques de pêche sont complétées par un développement agropiscicole.

Resumen

Gracias al nuevo régimen oceánico que amplía la jurisdicción pesquera, los gobiernos de los paises en desarrollo de Asia y otras partes, enfrentan una oportunidad única de mejorar sus deprimidas pesquerías costeras aprovechando la expansión del recurso. Este libro es una respuesta parcial a la necesidad resultante de una mejor comprensión de las limitaciones y oportunidades que enfrentan los pescadores de pequeña escala. Contiene 23 trabajos sobre captura de cultivo de peces en cinco países Asiáticos — Bangladesh, Malasia, Filipinas, Sri Lanka y Tailanda — basados en investigaciones originales auspiciados por el Centro Internacional de Investigaciones para el Desarrollo. Entre los temas cubiertos están las condiciones socioeconómicas, la productividad y eficiencia económica, la estructura de costo y rentabilidad, el mercadeo, las limitaciones sociales e institucionales, y los programas oficiales. Los autores concluyen que las posibilidades de expansión están limitadas de manera estricta por el tamaño del recurso. El éxito de cualquier plan de desarrollo pesquero será determinado por la efectividad de los planes de manejo que se adopten al tiempo con el desarrollo de controles sobre la entrada a la pesquería. Las mejoras en la productividad del recurso y en los niveles de vida solo serán posibles si las intervenciones relacionadas con la pesquería se complementan con el desarrollo rural sobre una base más amplia de recursos.

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Editor's Preface

This volume is the product, but hopefully not the end-product, of a learning-by-doing research effort by some 30 Asian researchers concerned with the problems of small-scale fisheries. It brings together the main research findings and their implications but it does not fully reflect the analytical skills and insights gained in the process. These are embodied in the persons of the researchers themselves, and many more were involved in the project than appear as the contributors to this volume, and should be reflected in subsequent research activities. The uneven level of analytical sophistication attained is not a sign of differential capacity to learn but of differences in the initial conditions.

The base-line data collected (and reported in more detail in the national volumes) and the relationships identified, estimated, and interpreted contribute to our understanding of the problems, constraints, and opportunities facing small-scale fishermen and should help in the formulation of policies and programs to upgrade their socioeconomic status. More importantly, the enhanced local analytical capability could be tapped to provide further inputs into policymaking by addressing unanswered questions and analyzing policy options. To the extent that the project, of which this volume is only a part, has helped enlarge the degrees of freedom for policy choices, its objectives have been accomplished.

On behalf of the authors of the papers included in this volume, I would like to acknowledge the financial and organizational support of the International Development Research Centre (IDRC) of Canada and the assistance of those governments, institutions, and individuals who directly or indirectly contributed to this project; unfortunately, it is not possible to mention them all by name.

I would also like to acknowledge, in addition to IDRC, the Rockefeller Foundation (1978–80) and the Agricultural Development Council (1981–82) for their agreement to and support of my participation in the project as researcher, technical coordinator, and overall editor of this volume.

Special acknowledgments should also go to the individual country editors–project leaders: Kamphol Adulavidhaya (Thailand), Sunimal Fernando (Sri Lanka), Leo J. Fredericks (Malaysia), Secandar Khan (Bangladesh), and Aida Librero (Philippines), who agreed to condense their national volumes into something more manageable and patiently responded to the demands placed on them. As it has not been possible to check the final outcome with them or their coauthors, it is hoped that the editorial "slash and burn" has retained the message and the flavour of the original papers.

It would be a serious omission if this acknowledgment were to be concluded without a note of thanks to Elwood A. Pye, IDRC Senior Program Officer, for the efficient management of the project.

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Foreword

This book presents the research findings of a five-country study funded by the International Development Research Centre (IDRC) on small-scale fisheries in Asia. The data gathered by the economists and other researchers in this project represents one of the most comprehensive social science studies of the sector.

Small-scale fishermen are important participants in the economies of South and Southeast Asia. They provide most of the animal protein for a rapidly expanding population. Fishing is also an important source of rural employment and income. It is estimated that 5% of the total labour force in Southeast Asia depends on fishing for their livelihood. Despite these contributions, small-scale fishermen occupy a position near the bottom of the income scale. Livelihoods are meagre for a variety of socioeconomic and environmental reasons that policymakers are only now beginning to recognize. Among these is the open access of the resource itself, which leads to overfishing in coastal and inland waters and results in dwindling stock, poor catch, and a perpetual cycle of poverty among fishermen.

In response to these problems, IDRC provided grants in 1979 to researchers in five countries for collection of primary data on small-scale fisheries. Working closely with policymakers, participants carried out research from universities and research centres in Bangladesh, Malaysia, the Philippines, Sri Lanka, and Thailand. The project had two primary objectives. First, there was the need to collect reliable data on the sector so that the more fundamental aspects of this industry could be better understood by government planners. Workshops have now been held for government officials in most of these countries. Second, the project attempted to improve the research skills of network participants. This was accomplished by introducing researchers to a wide variety of complex issues requiring statistical analysis. The papers in this publication reflect this process.

This book is the final outcome of this regional network and reflects the work over 5 years of a very dedicated group of researchers. The main credit for this publication, however, must go to Dr Theodore Panayotou, the network coordinator. His persistence in asking for analytical rigour as well as his attention to the relationship between research and policy show in the final results.

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Director, Social Sciences Division
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Introduction and Overview

Small-Scale Fisheries in Asia: An Introduction and Overview

Theodore Panayotou

This paper introduces the subject matter of the book, provides an overview of the issues discussed in the contributed papers, and highlights some of the findings. The book contains 23 papers on small-scale capture and culture fisheries from five Asian countries — Bangladesh, Malaysia, Philippines, Sri Lanka, and Thailand — contributed by nationals of these countries (with the exception of the editor). Virtually all papers in this volume are based on original field research carried out as part of a 3-year regional research project sponsored by the International Development Research Centre (IDRC). Their objective is to describe and analyze the socioeconomic conditions of small-scale fishermen in the countries concerned and to suggest policy alternatives where appropriate.

The papers are grouped to form the seven parts of the book: socioeconomic conditions, production technology and efficiency, cost structure and profitability, marketing system, social and institutional constraints, review of government programs, and aquaculture.

Definition

Although there is no standard definition of small-scale fisheries, various classifications of fisheries do exist: small-scale versus large-scale, subsistence versus commercial, artisanal versus industrial, inshore (or municipal) versus offshore; or fisheries may be classified according to vessel size (Indonesia and the Philippines), gear type and vessel size (Thailand), distance from shore (Singapore and Hong Kong), or a combination of the three (Malaysia). It is not unusual to find that what is considered a small-scale fishery in one country would be classed as a large-scale fishery in another. Although useful at the national scale, such narrow definitions are, as Smith (1979) pointed out:

> . . . not so useful when attempting to gain a broad understanding of the traditional fisheries sector. Rather than attempting to be specific, therefore, one could more usefully talk about ranges or rough categorizations of the technical and socioeconomic characteristics of the fishing activities of fishermen.

Our rough characterization in the present study is between those who have a broad spectrum of options both in terms of fishing grounds and nonfishing investment opportunities (large-scale fishermen) and those who, by virtue of their limited fishing range and a host of related socioeconomic characteristics, are confined to a narrow strip of land and sea around their community, faced with a limited set of options, if any, and intrinsically dependent on the local resources (small-scale fishermen).

Historical Background and Rationale

Since World War II, development efforts in South and Southeast Asia, as in other parts of the world, have focused on agriculture and industry. Fisheries, although often classified under agriculture, have been regarded until very recently as extractive industries whose development was identified with increased extractive capacity. Under the open-seas regime, larger and faster vessels meant a larger share of the common wealth of marine fisheries. It is understandable, then, that Asian governments have promoted, directly or indirectly, the mechanization and rapid expansion of their fishing industries. With rapidly progressing fishing technology and differential access to investment funds (including subsidized credit), promotional or even laissez-faire fisheries policies soon led to a dualism in the form of coexistence of large-scale industrial fisheries side by side with small-scale artisanal fisheries. For many years, the continued existence of traditional fishermen was thought to be a transitory feature of fisheries development and attracted little attention. It was hoped that the linkages and employment opportunities opened up by fisheries development and general economic growth would trickle down and revive stagnating coastal communities.

The persistence of small-scale fisheries and the apparently deteriorating socioeconomic conditions of coastal fishing communities led gradually to the realization that dualism was far from a transitory feature of fisheries development. A dualistic sector calls for a dualistic fisheries policy. Moreover, the failure of the benefits of general economic growth to trickle down and manifest themselves among the lower-income strata of the population (be they fishermen or farmers) and the consequent widening of socioeconomic disparities despite (or because of) rapid economic growth created a demand for direct intervention to alleviate rural poverty. In the fisheries domain, governments responded by formulating and implementing development-assistance programs for upgrading small-scale fisheries as early as the late 1960s. The emphasis of those programs was on mechanization and modernization of vessels and fishing methods through subsidies, concessionary credit, and even outright distribution of boats and engines at nominal prices. Provision of fishing-related infrastructure, such as landing and marketing facilities, was also part of the package.

The rationale behind such programs was more or less the same as the rationale behind the promotion of the industrial fisheries in earlier years: larger, faster, and more efficient vessels would afford the fishermen a higher share of the common fishery resources and hence a higher income. The difference was only the recognition that traditional fishermen could not join the race unassisted, that is, without special assistance beyond the general promotion of the fishing industry. The early successes of these programs in increasing the catch and income of the first few to acquire the new technology gave added impetus to these programs, many of which were intensified and expanded during the 1970s to cover a larger number of coastal fishermen.

Unfortunately, the early successes could not be duplicated. As more and more fishermen motorized and enlarged their boats, individual catches and incomes began to level off because the pressure on the limited fishery resources within their reach rose with the proliferation of the more efficient technology. True, modernization had increased coastal fishermen's fishing range but this brought them into more direct competition and conflict with the large-scale fisheries (mainly trawlers and purse seiners) operating further offshore as well as inshore. Although mechanization was not yielding the expected returns, it was, nevertheless, helping to maintain catches and incomes in the face of increased competition to which introduced mechanization was itself an important contributing factor. As nonmechanized operations began losing ground, the catch and income differential between mechanized and nonmechanized operations persisted, thus justifying continued promotion of mechanization. Political and social complications aside, termination of mechanization support would have meant denial of assistance to the remaining nonmechanized units to enable them, at least, to maintain their premechanization catch and income.

As maintenance costs rose with the age of the (now larger) vessels and engines and as fuel prices rose following the fuel crisis of 1973, the operating costs of mechanized vessels rose to the point of eliminating or even reversing their earlier income advantage over nonmechanized boats, although some still kept their edge in terms of catch. Under these conditions, it has become difficult to maintain the mechanization bias of development programs that are increasingly coming under scrutiny and review. At the same time, the wisdom of other related policy instruments, such as credit and subsidies, are being questioned. The need for government assistance to small-scale fishermen is as strong as ever, but conventional measures may not be the most appropriate modes of intervention.

In the meanwhile, the new ocean regime of extended fisheries jurisdictions, which brought the bulk of fishery resources under the "control" of coastal states, has changed the perception of the fishery from that of an extractive industry to that of a sustainable economic activity based on a renewable but destructible resource. Not only have the fishery resources under exclusive national jurisdiction been expanded, thus opening new opportunities for fisheries development, but also (and perhaps more importantly) the limits of these resources have been delineated and their vulnerability to uncontrolled fishing have become more apparent. The national fishery has now acquired a definite and exclusive resource base that is capable of certain maximum productivity if properly managed. Consequently, the need for and potential benefits from effective fisheries management have become more evident than ever before. Equally, the conflict between small- and large-scale fisheries, over the evidently limited resources within the national jurisdiction, has become more apparent especially since higher fuel prices increased the attractiveness of inshore grounds to large-scale operators.

Thus, Asian governments are facing three distinct but interdependent issues:

- How to attain a sustainable improvement in the socioeconomic conditions of small-scale fishing communities;
- How to manage the resource so as to maximize its productivity (or more appropriately the net economic or net social benefit from the resource); and

- How to allocate the country's limited marine fisheries between small-scale fishing communities and industrial fisheries so as to minimize the conflict between them.

Although these three objectives may not be mutually compatible in certain cases, in general and over the longer run, a properly managed fishery with reduced internal conflict would help alleviate poverty among fishermen and at the same time increase society's overall return from the fishery. Yet, because the number of active fishermen often far exceeds that which is required under a socially optimum management, improvements in resource productivity and in living standards could come about only if fishery-related interventions are complemented by rural development on a broader resource base (e.g., fish processing, aquaculture, mangrove felling, farming, mining, tourism, etc.).

The planning of such integrated rural development and resource management requires a considerable amount of information as to the demographic and sociocultural characteristics of fishing communities; their occupational structure, income levels, and other indicators of well-being; the size and quality of the resource base; the productivity, cost structure, and profitability of existing (and alternative) fishing technologies; the efficiency of the marketing system; the potency of social and institutional constraints; and the potential for alternative or supplementary economic activities such as coastal aquaculture. Because of the complexity of the problem and the rather disappointing results of past government programs, Asian governments are becoming increasingly concerned that their efforts to upgrade small-scale fisheries may be frustrated without such information and without a thorough understanding of the constraints under which small-scale fisheries operate and of the opportunities for further development.

Scope of Study

The papers in this volume represent a partial response to the need for socioeconomic information and a modest contribution toward a better understanding of the constraints and opportunities facing small-scale fisheries. They are based on original data collected through field surveys in five countries: two in South Asia (Bangladesh and Sri Lanka) and three in Southeast Asia (Malaysia, Philippines, and Thailand). Although the selection of countries is somewhat arbitrary, comparability, manageability, and expressed local interest played a role in the final choice. Under the budget limitations of the project, justice could not be done to Indian and Indonesian small-scale fisheries, the largest in South and Southeast Asia, respectively, and perhaps in the world; consequently, these two important fisheries are not included.

Although the emphasis is on coastal capture fisheries, inland capture fisheries and aquaculture are also considered, especially in Bangladesh and the Philippines, where they are of paramount importance. In fact, the Bangladeshi papers concentrate on inland fisheries to the exclusion of the relatively undeveloped marine fisheries. Bangladesh has extensive inland water bodies but a very limited coastline compared to the island states of the Philippines and Sri Lanka and the littoral states of Thailand and Malaysia (see Table 1). Yet the problems faced by fishermen in rivers and *haors* (natural depressions) in Bangladesh are not altogether unlike those faced by small-scale coastal fishermen in other Asian countries.

With the exception of the Philippines, where there is a well developed fish-farming industry,[1] especially for milkfish, the papers on aquaculture are of an exploratory nature, seeking to establish the potential for coastal and freshwater fish culture as an alternative or supplementary source of protein, income, and employment, especially for small-scale fishing communities.

As the title indicates, this volume focuses on socioeconomic analysis and the ensuing policy implications. It is an unsatisfactory feature that the underlying biological parameters, although not totally ignored, are not made explicit. However, there are good reasons for this omission. The multispecies feature of tropical fisheries does not lend itself to convenient bioeconomic modeling and, although there is a considerable body of biological research on individual fish species in the countries studied, little is yet known about the behaviour of multispecies stocks and their reaction to changes in fishing effort.[2] There is little doubt, however, that the project would have benefited from the inclusion of more fisheries biologists in the research team.

Another limitation of this volume is the static nature of the analysis. Changes in effort and adjustment in the stocks are assumed to take place instantaneously. In reality, exit and entry, stock adjustments and growth take time and "time is money." Benefits not earned now but later should be appropriately discounted because there is a cost to waiting (foregone interest); similarly, costs that are incurred in the future are not as "costly" as costs incurred today. Whether, and how much, fishing effort should be reduced to allow a fish stock to recover from overfishing depends on whether the benefits of waiting (increased future catch) exceed the costs of waiting (reduced present catch, idle fishing capacity, unemployment, etc.). Among the determinants of these costs and benefits are the growth rate of the biomass, the discount rate, and the rate of depreciation of fishing assets. In a dynamic world where time matters, the goal of management should be the maximization of the present value of net revenues over time. Unfortunately, the cross-sectional short-term nature of the data on which the studies in this volume are based and the paucity and limited reliability of existing time series preclude full consideration of the time dimension of the issues studied, although allowances were made where possible.

An important objective of the project has been the enhancement of local analytical capability for policy-relevant research on small-scale fisheries. Hence, the emphasis was on team work carried out by local researchers using the locally available research facilities. Because of this learning-by-doing feature of the research process, the papers are of variable quality and level of sophistication despite substantial technical and editorial inputs. Yet, they address related issues, employ a similar conceptual framework and arrive at roughly comparable results. To facilitate comparisions, Table 1 provides comparative profiles of the fisheries and countries and the conversion rates for local currencies.

Overview of Issues and Findings

The papers are grouped into seven sections. The first establishes, for all five countries, the general socioeconomic conditions and income levels of

[1]Thailand also has a significant fish-farming industry, especially of catfish, which has been studied under a separate project (see Panayotou et al. 1982).

[2]More is known today than a few years ago of how to approach the issue of multispecies fisheries with incomplete information (see, for instance, Pauly 1979 and Panayotou 1982).

Table 1. Comparative country profiles for fisheries, 1978.

	Bangladesh	Malaysia	Philippines	Sri Lanka	Thailand
		General			
Area (km^2 x 10^3)					
Land	143	333	297	66	513
Shelf to 200 m depth	40	419	184	28	395
Length of coastline (km)	700	3432	17640	1700	2614
Population (x 10^3)	83477	13477	46374	14346	44300
Gross domestic product (US$ x 10^6)[a]					
Total	7638[b]	15487	23438	2467	18522
Agricultural	4098[b]	2332[c]	6390	780	5272
Private consumption expenditure (US$)	70	634	330	126	278
		Fisheries			
Production (ton x 10^3)					
Food	737	480	1557	156	1142
Feed	–	20	1	1	1048
Imports (ton x 10^3)					
Food	–	157	59	12	24
Feed	–	165	91	–	0[e]
Exports (ton x 10^3)					
Food	6	130	46	5	141
Feed	–	13	–	–	415
Total supply (ton x 10^3)					
Food	731	507	1570	163	1025
Feed	–	172	92	1	633
Supply per person (kg)	9	38	34	11	23
Employment (x 10^3)[f]					
Primary	700	108	900	67	72[d]
Secondary	na	na	30	14	275
Values (US$ x 10^6)					
Output	370	670	1285	51	533
Imports	0[e]	54	31	2	69
Exports	16	105	63	15	254
Foreign exchange	17	–	72	15	–
Fisheries contribution to GDP (%)	5	–	6	–	–
Inland fisheries					
Total area (ha)	–	–	176	120	571
Production (ton x 10^3)	735[c]	62	119	na	122

Source: FAO Fishery Country Profile, 1978 and 1979 issues.

[a]Exchange rates to US$1: 15.15 takas (BDT), 2.31 ringgits (MYR), 7.38 pesos (PHP), 15.63 rupees (LKR), and 20.40 baht (THB).

[b] [d]b, 1977-78; c, 1975; d, 1976-77.

[e]Negligible.

[f]Full-time fishermen.

small-scale fishermen. The second to fifth sections attempt to explain differences in income levels among fishermen in selected cases by studying the productivity/cost structure and profitability of different fishing technologies (gears) in different locations, the efficiency of the marketing system, and the role of social and institutional constraints. Section six reviews past and present government programs and section seven examines the potential of aquaculture as an alternative or supplement to coastal fishing.

The balance of this chapter is a brief description of the subject matter of each section and contains highlights from the findings of each paper.

Socioeconomic conditions

This section provides the background and basic information for the remainder of the study by describing the prevailing demographic, social, and economic conditions of a sample of small-scale fishing communities in each country. More specifically, information is given on such variables as family size, education, fishing and nonfishing employment, income levels, and the "relative" contributions of fishing and nonfishing sources to standard of living. The paper by Panayotou provides a conceptual framework for the studies that follow it emphasizing the need to measure relative rather than absolute incomes and to assess standards of living based on a set of socioeconomic indicators, not just income. It also suggests possible models for explaining income differentials that lead into subsequent sections of this volume.

The paper by Librero, Catalla, and Fabro compares income levels and other indicators of well-being of municipal fishermen and fish farmers in the Philippines with those of rice and coconut farmers and concludes that municipal fishermen with an annual net household income of US$675 (58% from fishing) were, on the average, better off than rice farmers with US$476 but not as well off as coconut farmers with US$804, and far below the rural and national averages of US$932 and US$1149 respectively. In contrast, fish farmers' incomes, US$3378, were found to be almost three times the national average. Moreover, important regional differences were identified: in Luzon and Mindanao, fishermen's annual incomes approched the rural average, but in the Visayas they lagged far behind, US$223, suggesting the latter as a priority area for government assistance. In terms of the ratio of food expenditure to total consumption expenditure and other indicators, such as ownership of residential lot, water supply, and toilet facilities, fishing households compared unfavourably to both rice- and fish-farming households.

The paper by Fredericks, Nair, and Yahaya compares income levels, employment, and income distribution between East and West Coast fishermen in Peninsular Malaysia and makes three main conclusions. First, coastal fishermen in Peninsular Malaysia earned on the average a gross annual income of US$2246 (95% from fishing), which compares favourably with the rural average of just under US$2000. Second, there were wide regional differences, with East Coast fishermen (mainly fishing labourers) earning less than one-third the income of West Coast fishermen and less than half the rural average, or about as low as paddy farmers, US$844; a finding that suggests the East Coast as a priority area for government assistance. Third, there is evidence of negative correlation between surplus labour and income levels and between income levels and inequality (income distribution was more skewed on the East Coast).

The paper by Panayotou, Aduladvidhaya, Artachinda, Isvilanonda, and Jitsanguan compares and analyzes income levels and other indicators of well-being among four coastal provinces of Thailand — Chumporn, Nakhon Si Thammarat, Pang Nga, and Trat. It was found that coastal fishing households as a group were at least as well off as the average Thai citizen. The average fishing household's annual income was about US$2500, which compares favourably with the national average. However, there was considerable variation among locations: Trat and Chumporn households earned incomes that were two to three times higher than those of Nakhon households whereas households in Pang Nga fared slightly better because of the availability of nonfishing employment opportunities. Nakhon and similar locations suffering in terms of both an unprofitable fishery and lack of alternative employment were identified as priority areas for government assistance. Even in the better-off locations, however, the variance of incomes was considerable, suggesting that some fishermen there had incomes substantially below the norm. (A related study in the third section identifies these fishermen by type of gear and scale of operation.)

After a brief historical overview of the Sri Lankan fishery sector, Munasinghe estimates the incomes of boat owners and crewmen by type of gear and location. In contrast to the three Southeast Asian cases just reviewed, she found that boat owners with average annual incomes ranging between US$1150 (traditional craft) and over US$5000 (3.5-ton mechanized vessels) were by far better off than comparable socioeconomic groups such as owner-cultivators and sharecroppers, or office workers and state employees who earned under US$500/year. Similarly, the average daily earnings of crewmen on motorized boats (including indigenous craft), US$5/man-day, were two to three times higher than the daily earnings of agricultural labourers and unskilled and semiskilled workers. Only crew members on nonmechanized traditional craft earned incomes comparable to those of agricultural workers (US$1.50/man-day). Only 6% of the surveyed fishing households engaged in any nonfishing activities, mainly the civil service and trade. The author attributes fishermen's relatively high incomes to sociocultural barriers to entry (closed communities), their chronic indebtedness to their propensity to overspend on luxury items, and the absence of expansion into a large-scale fishery to their tendency to invest any savings in nonfishing ventures. In the light of her findings, Munasinghe questions the need for and fairness of continued government subsidization of the fishery.

Huq and Huq, in their study of natural-depression (*haor*) fisheries in Bangladesh found considerable variability among locations with total household annual incomes ranging from under US$750 to over US$1900. Interestingly, they found that this variability could not be explained by differences in ownership of land or other nonfishing assets: instead, fishing assets and fishing and nonfishing employment were found to be significant in different locations. It was further found that income was more equally distributed than assets, and levels of income and degree of inequality were, unlike the Malaysian case, inversely related. On the average, *haor* fishermen had a higher rate of literacy and income than the rest of the rural population. The higher earnings of fishermen, displayed in higher expenditures on social goods and higher savings, are attributed more to hours of work than to higher pay (farming paid a higher wage). Fishermen were better off than rural dwellers in general among whom many were landless and underemployed, which raises the question of mobility in and out of the fishery.

Production technology and efficiency

Having assessed the relative income position of fishing households in the first section by considering both fishing and nonfishing activities, the next five sections focus almost exclusively on fishing. The second section attempts to explain the variability of catch among fishermen based on the quantities of inputs they use, the type of fishing gear they employ, and the location of the fishing ground in which they operate. Some social characteristics that might affect management ability are also considered. The outcome is an evaluation of the productivity of different fishing inputs, a comparison of the technical efficiency among fishing gears and fishing grounds (and their combinations), and an assessment of the economic efficiency of input use.

The introductory paper by Panayotou provides a conceptual framework in the form of a fishery-production function that can be estimated with cross-sectional data to obtain the traits of the production technology, such as the marginal products of fishing inputs, their production and substitution elasticities, returns to scale, and the significance of qualitative variables. These measures can, in turn, be used as "inputs" in the study of technical and economic efficiency.

The paper by Tokrisna, Panayotou, and Adulavidhaya is an application of this framework to the coastal fishery of Thailand, using cross-sectional data for the same sample of 891 fishing households used in the socioeconomic study reported in the first section of this book. Production functions were estimated by type of fishing gear and by location, as well as for combined gears and locations. It was found that technical efficiency varied both among gears operating in the same location and for the same type of gear operating in different locations. Overall, the most productive types of gear were shellfish rakes in Trat, purse seines in Chumporn, push nets in Nakhon Si Thammarat, and set bag nets in Pang Nga. Similarly, returns to scale varied across gear types and locations. In terms of price efficiency, it was found that it would be profitable (in private terms) for fishermen with the less-traditional types of gear to increase the size and engine power of their vessels whereas those with more traditional types should increase the use of labour. Profitability of several gear types, especially those operated by inexperienced fishermen, could be increased by reducing fuel consumption. In general, management ability was a significant explanatory variable. In terms of social profitability, it was judged appropriate for virtually all types of gear to be given incentives to use more labour.

Fredericks and Nair apply the same analytical framework to a sample of 261 coastal fishermen in Peninsular Malaysia. They found that fuel consumption was the most significant explanatory variable across gears and locations, suggesting fishing time or horsepower, or both, as limiting factors on catch. No significant differences were found between the East and West Coasts of the Peninsula in terms of resource availability in the cases of trawling and shellfish collection: this is surprising given the widely held view that the West Coast fishery resources are "overexploited" (see also Fredericks et al., in this volume, p. 176). Within the framework of an all-gear all-location production function, fuel, vessel tonnage, gear length, mesh size, and fishing time could explain as much as 90% of the total variation of catch among fishermen. With the exception of handlines on the East Coast, the use of fuel was found to be below the economically optimum level. The employment of labour was also found to be below its price-efficient level (except for Pantai Remis trawl nets), a particularly important finding in the light of "surplus" labour found in Malaysian fishing communities.

Khaled employs a *translog* production function to estimate the productivity and substitutability of fishing inputs, and to evaluate the efficiency of resource allocation and the profitability of investment in the riverine fishery of Bangladesh. He found that use of fewer or smaller nets, more labour, and larger boats would increase catch. Labour and boat size were found to be complements whereas labour and nets and boat size and nets were substitutes within limits. No significant difference in the productivity of drift nets and seine nets was found suggesting that the government should promote the less expensive drift nets. Khaled infers from his finding that a doubling of effort would lead to only 89% rise in catch (due to the fixity of the fish stock) and that the rental value of the fish stock is 11% of the gross revenues from fishing. He therefore suggests that the government should raise the leasing fees for the resource. In terms of private profitability, he recommends that, at current input prices, the inputs of labour and net should be reduced and that of boat be raised, a policy that may not be socially optimal when considering the very low social opportunity of labour in Bangladesh.

Cost structure and profitability

In this section, we take a closer look at fishing incomes, analyze the composition of fishing costs, and evaluate the viability of small-scale fishing operations as a commercial activity. Fishing costs are classified into fixed and variable, cash and imputed, and domestic and external, and the shares of individual inputs such as fuel, capital, and labour are computed and compared to assess the vulnerability to external factors and to measure the relative factor intensity of different fishing technologies. Various indices of profitability are defined and computed to assess the short- and long-term viability of fishing operations and the degree of economic overfishing arising from the open-access status of the fishery resources.

As in the preceding two sections of this volume, the paper by Panayotou lays out the conceptual framework of the studies that follow with emphasis on economic rather than accounting concepts of costs and profits. The sharing system of labour remuneration and the concepts of resource rents and open access are also discussed in some detail.

Fernando compares the cost structure and profitability of different fishing technologies and fishing sites in Sri Lanka in terms of fuel consumption, dependence on external inputs, and generation of resource rents. He found that the higher the degree of mechanization and modernization of the fishing unit, the higher was the net income of the owner-operator and his crew and the greater the dependence on external inputs, including imported fuel. All types of fishing gears, whether traditional or modern, mechanized or nonmechanized, were found to earn positive and substantial resource rents that the author attributes to quasi-property rights. Most profitable were the beach seines, which literally controlled sections of the sea bordering the shoreline. Barriers to entry coupled with the sharing system of labour remuneration resulted in a return to fishing labour substantially higher than labour's opportunity cost (the agricultural wage rate). Interlocational differences in fishing incomes are also attributed to differences in resource abundance and in the effectiveness with which customary community rights over the resource are protected. In the light of his findings, the author calls for:

- Recognition of the conflict between policies that encourage mechanization and those that aim to reduce dependence on external inputs;
- Reexamination of the need and fairness of continued subsidies for craft and gear; and

- A clear policy decision on customary fishing rights and distribution of rents.

Librero, Ramos, and Lapie compare mechanized and nonmechanized fishing units in the Philippines in terms of catch, cost structure, and profitability. They found that most types of gear were more productive when used in motorized boats; for certain types such as beach seines, however, motorization was not an apparent advantage. The total cost of a motorized boat was on the average four times that of a nonmotorized boat. Fuel was the largest single cost item for motorized boats, accounting for 37% of total cost. Labour costs accounted for 38% of the total costs of nonmotorized boats but only for 22% of the costs of motorized boats; of the former percentage, half was the imputed cost for family labour compared to less than one-third for the latter. In the Visayas, nonmotorized fishing units earned a net income several times higher than motorized boats. A similar situation was found in Luzon except that the difference was smaller. In contrast, in Mindanao, the reverse occurred with motorized boats earning 30% more than nonmotorized boats. For the Philippines as a whole, nonmotorized boats fared 12% better in terms of net family income and 67% better in terms of net profit than nonmotorized boats. Moreover, nonmotorized boats earned, on the average, positive resource rents whereas motorized boats had considerable losses. The reasons are clear: the fishing costs of motorized boats were four times higher than those of nonmotorized boats but their catch was only twice as large. Moreover, the unit value of the catch of motorized boats was 22% lower than that of nonmotorized boats. The combined outcome of these factors was a negative return to capital for motorized boats compared with a 72% return for nonmotorized boats, a finding that has important implications for the policies that promote motorization.

The paper by Panayotou, Jitsanguan, and Adulavidhaya defines scale of operations in terms of the current value of fishing assets and compares indebtedness, cost structure, and profitability between small- and medium-scale gear groups in four coastal provinces of Thailand. Small-scale gear groups had, on the average, smaller debts, but in relation to the value of their assets they had borrowed more; they paid the same interest rate as medium-scale units except in isolated areas such as Nakhon Si Thammarat where they had borrowed from noninstitutional sources at interest rates of 51%, compared with the institutional rate of 12%. There was no significant difference in the share of fixed costs and hence in the flexibility between small- and medium-scale operations. The cost share of fuel, the main cash-cost item, was lower for small-scale units, which were more labour intensive although they hired little labour outside the family. Therefore, cheap-fuel, cheap-labour policies tend to favour the medium-scale fishermen who use relatively more of both these inputs. Limited capital is usually the binding constraint for small-scale operations; however, subsidized credit to all fishermen would not necessarily solve the problem because of the fishery-resource constraints. Medium-scale units earned, in general, higher profits and resource rents than small-scale units but this rule was not without exceptions. For instance, trawlers in Chumporn incurred considerable losses because of the overfished state of the demersal resources in the area. In contrast, purse seines, a pelagic gear, in the same area and trawlers in Trat (near the lightly fished Kampuchean waters) earned enormous resource rents. Among the unprofitable (negative resource rent) gears were crab gill net in Chumporn, winged set bag in Nakhon, push net in

Pang Nga, and fish gill net in Trat. All other small-scale gears, including nonpowered ones, were profitable although they generated only subsistence level income because of the low opportunity cost of labour. In conclusion, economic overfishing was found to exist in relation to certain combinations of gears and fishing grounds. For the small-scale fishery as a whole, there were still some but not substantial rents.

Fredericks, Nair, and Yahaya compare cost structure and profitability among the major gear types of the East and West Coasts of Peninsular Malaysia. The major component of capital costs was found to be engine cost, which accounted for 59% of total capital costs on the East Coast and 39% on the West Coast. Labour costs accounted for over 66% of operating costs on the West Coast compared with about 40% on the East Coast. In contrast, fuel accounted for as much as 35% of the operating costs on the East Coast, but for less than 15% on the West Coast. These differences had to do with the differential capital intensity and wages on the two coasts. Landings by fishermen on the West Coast were only a fraction of those of East Coast trawl nets, but they were of higher unit value. The most profitable gear types were trawl nets and handlines in Kuala Trengganu on the East Coast, apparently because of larger catches and lower labour costs. With the exception of shrimp trawl and drift nets, the West Coast fishing units incurred considerable losses. Thus, crew members were found to be better off on the West Coast and boat owner-operators better off on the East Coast, a finding that is in agreement with the high opportunity cost of labour and the overfished state of the West Coast fishery resources. To the extent that the period and sites sampled are representative of the West Coast fishery, it can be concluded that all resource rents have been dissipated. In contrast, on the East Coast, rents seem to persist and coexist with what appears to be a situation of chronic "surplus" labour, which could be an indication of barriers to entry in the form of high capital and skill requirements.

Marketing system

This section looks closely at what happens on land in relation to fishing inputs and catch. This is important because fishing incomes (or profits) depend not only on the amount of catch but also on its unit price at the market (or at the landing site) as well as on the cost of inputs used in the production process.

The issue of middlemen and fish traders is central to this section. Is there exploitation of fishermen by middlemen or are the middlemen receiving a "just" price (the opportunity cost) in return for their service? If indeed there is exploitation in certain cases, what are the necessary and sufficient conditions for its existence and persistence? Why is it that competition among middlemen does not eliminate exploitation? What is the role of isolation, immobility, and indebtedness in this connection?

One approach to this problem is to follow the fish from the landing site to the consumer (and each fishing input from the main distribution centre to the fishing site) and examine whether the services provided in between (such as transport, handling, marketing expenses, risk-bearing, etc.) suffice to justify the difference in price between the two end points. The number and share of traders relative to the size of the market at each stage in the marketing process must be considered. Credit provision as well as social relations between fishermen and middlemen may also play a key role in the final outcome.

Fernando tests the widely held hypothesis that middlemen "exploit" the fishermen through loan-secured preemptive marketing, based on a sample of 284 assemblers and retailers and a census of retail fish traders in 33 retail markets in Sri Lanka. He examines the fishermen's dependence on credit from fish traders (17%), the dominant mode of fish sale (auction), the number of traders both at the wholesale and retail level (large, 25–75 traders at most fishing centres), and the possibility of price leadership by a dominant trader (no dominant traders, more or less equal capital assets). He concludes that the fish marketing system in Sri Lanka is fairly competitive. It is more competitive today than in the past because of the improved transport and communication network, and the increased profitability of fishing, which allows internal generation of investible funds. He also found that fish traders, especially those supplying such new markets as the interior and export, are earning substantial profits (above their opportunity costs), which he attributes to rents of ability and risk premiums associated with these new ventures. He cites indications that entry into these markets is taking place and concludes that the currently observed profits are disequilibrium or short-run rents. He recommends government intervention to identify and diffuse the required skills for successful fish marketing, to develop more efficient means of transport, and to facilitate the flow of market information to the fishermen, thus reducing any frictional inefficiencies in the marketing system of Sri Lanka.

The paper by Librero is based on secondary data and earlier work by the author and others on the marketing system of the Philippines. After analyzing market structure in terms of the degree of concentration of sellers and buyers, product differentiation, and conditions of entry and exit, the author concludes that the fish marketing system in the Philippines is imperfectly competitive and approaching oligopoly in many cases: the number of sellers is small relative to that of buyers; the product is differentiated according to species, size, and freshness; and entry into fish trading is not always easy because of capital and skill requirements. The most common marketing practices are auction sale, contract sale, and sale on a first-come-first-served basis. Fish auctions in the Philippines are of particular interest because of the so-called "whispering system" used in receiving bids. This allows the seller to take into account nonprice considerations, such as the credit standing, honesty, and loyalty of the buyer, so that the sale does not always go to the highest bidder. In general, fish prices varied directly with size and freshness and inversely with the credit standing of the buyer, the size of the lot bought, and the volume of fish available in the market. Librero concludes that, to increase the efficiency of the marketing system in the Philippines, it would be necessary to develop more landing facilities, improve the distribution of ice plants, and reduce the number of links in the market chain.

Social and institutional constraints

Although the rest of this volume gives the opportunity to discuss social and institutional constraints (especially the issues of common property and leasing of property rights), this section gives a detailed analysis of noneconomic factors impinging upon small-scale fisheries performance, management, and development. The connection between this section and the rest of the volume should be clear. In other sections, economic factors and relationships are analyzed with the sociopolitical and institutional structure as a "given"; in this section, the reverse is done: noneconomic factors are analyzed taking economic relationships more or less as given. For instance, the Sri Lankan studies elsewhere in this volume found that fishermen were earning incomes above their opportunity costs, a finding that implies barriers to entry into the fishery. To what extent has Buddhism's teachings against the taking of life been an effective barrier to entry and so been responsible for the persistence of resource rents in an otherwise open-access fishery? After all, Buddhist fishermen would be willing to enter the fishery only if they could earn sufficient profit to be compensated for the social stigma of being engaged in a sinful occupation. In any case, they would need some additional cash for merit-making to wash away the sin. Other hypotheses tested in this section relate to caste restrictions, customary and leased fishing rights, and the social organization of production. Both papers in this section come from South Asia.

The paper by Fernando, Devasena, Banda, and Somawantha test a widely held hypothesis that Buddhism's doctrine of nonviolence to living beings has been an effective constraint on the development of the Sri Lankan fishing industry. The authors examine first the Buddhist doctrinal position and conclude that, although "slaughter trades" such as fishing are not compatible with the First Precept — against the taking of life — fishing is an empirical reality that Buddhism does not oppose in isolation. What Buddhism advises is not giving up fishing as an occupation but the abandonment of its root cause, craving, which has conditioned birth "in the midst of a set of circumstances in which participation in slaughter trades such as fishing could not be evaded."

At the empirical level, the authors found strong evidence that, although Buddhist fishermen and nonfishermen perceived fishing as a sinful occupation, they did not constrain their economic behaviour accordingly. On the one hand, there was reluctance by certain social groups to engage in fishing; on the other, Buddhist fishermen expressed desire to stay in fishing even if comparable nonfishing alternatives were provided. Moreover, nonfishing groups with lower incomes were prepared to enter the fishery if they could earn a better living. The authors surmise that, with the exception of Tamil-speaking Hindu fishermen who are constrained by caste, economic factors supersede sociocultural factors at lower income levels whereas the reverse occurs at higher income levels. This is supported by evidence that the more successful fishermen invest their savings outside fishing despite a higher return from fishing. If religion is not a barrier to entry into fishing, then what accounts for the substantial resource rents earned by capital and labour engaged in fishing? The authors suggest that there are barriers to entry in the form of customary fishing rights vested in fishing communities: outsiders are not allowed to fish in community fishing grounds and labour is not recruited from outside the community. There are signs, however, that the closed fishing communities are beginning to open up under the pressure of increasing labour shortages.

Mahbub Ullah analyzes the production organization of riverine fishing in Bangladesh focusing on the hiring, leasing, and credit relations and the class stratification of fishing teams. He prefers to talk of relations rather than markets because of the intermixing of economic and sociopolitical functions uncharacteristic of modern market economies. It is a characteristic of the labour-hiring relations that the functional role of the entrepreneur (fishing-team leader) is not separated from that of the worker (crew); kinship and factional loyalties and noneconomic exchanges are important and, hence, direct remuneration does not reflect total compensation. Often, labour hiring, credit, marketing, and even leasing relations become intertwined as the team leaders give workers wage advances that they borrow from merchant lessees from whom they also rent the use of the fishing grounds and to whom they become obliged to sell their catch. Although fishing rights are nominally auctioned by the government to the highest bidder, the leasing of these rights has actually become a hereditary occupation of a group of people (merchants and money-lenders) who enjoy low policing costs over these rights through the creation of local power structures and the manipulation of the government bureaucracy. Fishing-team leaders obtain the right to fish in a lessee's section of the river on payment of a fixed rent or a share of the catch, which varies depending on the team leader's share of policing costs. Although the lessees impose no limitation on fishing effort, the undesirable state of a bioeconomic (or open-access) equilibrium does not prevail because of the contractual arrangements among the concerned parties, that is, the government, the lessee, and the fishing team. Rents, whether fixed on the basis of fishing assets or as a share of the catch, serve to limit effort, although not necessarily to the rent-maximizing level. Moreover, caste restrictions on occupational change have instilled a resource conservation ethic in traditional Hindu fishermen at the same time as "food-for-work programs" have restrained the flow of landless Muslims into the fishery. Virtually all 52 fishing teams sampled by the author earned positive rates of profit, in addition to the rent paid to the lessees of the fishing grounds.

In the second half of his paper, Mahbub Ullah uses the so-called "labour exploitation" criterion (roughly the ratio of hired labour to family labour) to stratify his sample of 52 fishing-team leaders into protocapitalists and upper and lower artisans. Through a production-function analysis, he finds lower productivity among protocapitalists (i.e., those with high labour exploitation ratios), which he attributes to a diminished "concern" for fellow team members. The rates of profit, however, do not differ among the three classes because the "intertwined relations and varying degrees of freedom and unfreedom in exchange relations tend to even out the effect on the rate of profit earned." In conclusion, the author suggests continuation of the existing fishing-right arrangements with corrective measures such as increased competition among and taxation of lessees, explicit restrictions on fishing effort based on stock assessment, a more equitable return for the parties involved, and expansion of educational and employment opportunities to counter the increasing pressure on the riverine resources.

Review of government programs

Although each section of the volume reviewed thus far includes a discussion of policy implications, the sixth is intended for evaluation of specific government policies and programs and for recommendation of possible alternatives in the light of the findings of both this and earlier sections. The framework for the papers in this section includes a description of the government program under consideration, the factors that led to its inception, its objectives as set out and evolved through its active life, and its instruments, followed by the assessment of the program's impact, i.e., the difference between the current situation and that which would have prevailed in its absence. Because many other programs, some unrelated to fisheries but affecting them, are often implemented concurrently, the sorting out of the effects of a particular program is not easy. The outcome or impact of a given program once isolated from other influences may be compared to the stated program objectives and to comparable alternatives.

Based on a sample of 500 fishermen borrowers and nonborrowers, Librero and Catalla evaluate the credit program for Philippine municipal fishermen. This program, which was put into effect in 1974 by the Development Bank of the Philippines, permits loans for municipal fishermen up to 5000 PHP/ borrower without collateral requirements (7.38 pesos [PHP] = US$1). The performance of the credit scheme is evaluated in terms of repayment and of impact on technology, catch, income, and general welfare of the recipients. By 1979, only 1% had fully repaid their loans, 64% had made partial payments, and 35% had made no payment at all. In terms of impact, the credit program contributed significantly to enlargement and motorization of vessels, to modernization of gear, and to expansion of fleet but very little, if at all, to production, incomes, and general welfare because of the limited fishery resources, their open-access status, and circumstances unforeseen at the initiation of the program, such as the rise in fuel prices. In the light of these findings, it is imperative to reexamine and restructure credit and similar programs to account for factors that have been found to impinge upon their performance both in terms of repayment and impact.

The paper by De Alwis reviews critically the Sri Lankan fishery policies and programs since 1950: credit and subsidy schemes for the mechanization and modernization of fleet; construction of fishing harbours and anchorages; provision of public services and community infrastructure; promotion of fishermen's cooperatives and state marketing; and other areas of government involvement, ranging from training and research to fisheries legislation and foreign assistance. Particular attention is paid to the Master Plan for Fishery Development 1979–83, and its prospects for remedying some of the difficulties and deficiencies of earlier programs. For instance, the Master Plan continues the liberal subsidy (now set at 25–35% for craft and 50% for marine engines) initiated by earlier programs, and provisions are made for dealing with some of the problems (e.g., insufficient supply of spare parts and fishing gear and increasing fuel prices) although not with others (e.g., nonrepayment of loans and fishery resource constraints). The issuing of subsidized boats has been governed by factors other than the availability of fishery resources and of infrastructure facilities and, as a result, there are pockets of overexploitation of resources and underutilization of facilities. Fishermen's cooperatives have been largely unsuccessful and, correctly, the Master Plan plays down their role in future fishery development (except in the area of marketing). Of doubtful value is the planned building of cold stores and buffer stocks at the Ceylon Fisheries Corporation, which has been unable to achieve its objective of breaking the "monopoly" power of the middlemen and having any impact on market prices. In a policy-implications postscript, Fernando raises the issue of efficiency versus equity in the mechanization/infrastructure policy and recommends changes not totally out of the spirit of the Plan.

Aquaculture

The inclusion of studies on aquaculture is an integral part of this volume because many of the problems faced by small-scale fishermen are common to small-scale fish farmers. More importantly, however, aquaculture holds the promise of becoming a viable alternative to capture fisheries. With the increasing depletion of fish from natural sources and the rising employment and income needs of small-scale fishermen and other socioeconomic groups, aquaculture's potential contribution toward better nutrition, additional employment, and higher incomes, as well as toward better utilization of marginal lands, cannot be ignored. The long experience of fish-farming in the Philippines and other countries in Southeast Asia may prove to be of great help to countries in South Asia such as Sri Lanka and Bangladesh that are planning the promotion of aquaculture, provided that due attention is paid to geographical and socioeconomic differences.

Librero and Perez estimate and compare the productivity and profitability of various fish-culture practices in the Philippines based on a sample of about 200 fish farms from 13 provinces. Among the farming practices (or technologies) considered are monoculture versus polyculture, stocking of fry versus fingerlings (or a combination), use of fertilizer, pest eradication, different sources of feed, stocking rates and number of rearings per year, pond size, and alternative combinations of inputs. The most widely used combination of practices was found to be monoculture of milkfish with *lablab* as the main source of feed (no supplementary feeds), combined use of fertilizer and pesticides, bulk stocking of fry at the rate of 1000–4000 animals/ha, and two or three rearings per year in ponds under 10 ha in area. Productivity or yield per hectare was highest, 1200 kg/ha, in monoculture farms that were densely bulk-stocked with fry and practicing fertilization and pest eradication; it was lowest, 500 kg/ha, in farms that used no material inputs other than staggered stocking of fingerlings at rates below 1000/ha. Small ponds were more, or at least no less, productive than larger ponds. Perhaps more importantly, small ponds (less than 2 ha) using the carefully controlled practices mentioned above generated the highest net income. Although higher productivity generally meant higher profitability, polyculture ponds were, on the average, 36% more profitable than monoculture ponds although the latter were 48% more productive. The reason is that polyculture farms rear high value species such as prawn and crab along with milkfish. A production-function and efficiency analysis confirmed that the stocking rate and fertilizer use were the most significant limiting factors for both output and profit. Both these inputs could be profitably increased. Correspondingly, the pond area was found to be underutilized and considerably above its optimum size, which suggests that production and income could be increased through more intensive use of existing pond area. This would allow the conservation of the remaining mangrove areas in accordance with government policy. Intensification of fish culture, however, may require government assistance to fish farmers facing capital and technological constraints.

The paper by Omar investigates the economic viability of small-scale coastal aquaculture in Peninsular Malaysia based on a sample of 80 fish farms. In terms of alternative profit criteria, the returns to investment in coastal aquaculture were found to be relatively high. For example, the computed internal rate of return was over 45%, which is more favourable than most other investments in the agricultural sector. Even after a 20% hypothetical increase in the costs of fry and feed or a 20% decline in fish prices, all systems studied continued to have positive net present values. Omar concludes that small-scale aquaculture is economically viable as a supplementary or alternative source of income and employment for small-scale fishermen, provided that the government offers appropriate incentives at the initial stage of the enterprise. Credit availability for the initial capital outlay, correct site selection, and marketing are identified as the key factors for the successful development of coastal aquaculture.

Bakar's paper investigates the economic viability of freshwater aquaculture in Peninsular Malaysia based on a sample of 150 fish farmers, of whom 84% operated excavated ponds and the balance, disused mining ponds. Although excavated ponds are not unprofitable, disused mining ponds are considerably more profitable because of zero excavation costs and economies of scale. However, many disused mining ponds lie unutilized (and the stocking rate in utilized ponds is far below the optimum) for two reasons. First, a deliberate policy promotes the 0.25- and 0.5-acre (0.1- and 0.2-ha) excavated ponds as part of a poverty-reduction program that excludes the much larger mining ponds. Second, mining companies are reluctant to give up their rights to remine them in the future, thus creating uncertainty of tenure through temporary operation licences.

The paper by Khan is a first attempt to explain the paradox of about 523 000 water tanks and ponds (over 69 000 ha) suitable for fish culture remaining largely unutilized in a country such as Bangladesh, which faces severe land and food shortages. Based on a survey of 78 fish ponds from Comilla and Chittagong districts, the author tests a variety of hypotheses as to the constraints to utilization of ponds for fish culture, ranging from actual and perceived unprofitability through multiple ownership and insecurity of tenure to physical features of the ponds (age, size, and depth) and socioeconomic features of their owners (age, education, occupation, family size, income level, etc.). He found that fish culture in his study areas was more profitable than alternative uses (rice production) of land in Bangladesh and more profitable than fish culture in Southeast Asia (in terms of profit rate). He found no evidence that owners of unutilized ponds were unaware of the potentially profitable use of ponds for fish culture. Therefore, he rejects both perceived and actual profitability as a factor in the nonutilization of ponds. However, the role of multiple ownership and insecurity of tenure could not be rejected. Moreover, it was found that older and smaller ponds and ponds held primarily for other uses (household water supply) are less likely to be used for fish culture. Another important finding is that the owners of unused ponds had, on the average, a higher educational level and income and fewer dependents than the owners of utilized ponds, which suggests different opportunity costs between the two groups. This implies that, although pond utilization for fish culture might be socially and privately profitable (on the average), it might not be so for pond owners with high opportunity costs, a finding with obvious implications for land reform. Policy recommendations include community-level management of resources that include ponds, release of ponds for fish culture through construction of village water tanks and tube wells, introduction of new species for culture, cleaning and deepening of ponds through use of cheap labour during the dry season, and encouragement of fish farmers to increase stocking rates, which were found to be below their profit-maximizing levels.

Senanayake and Fernando make the case for the introduction of high-value fish such as red snapper and estuarine perch into inland water bodies (artificial lakes and tanks) of Sri Lanka to add to their trophic diversity and convert much of the smaller fish found in these tanks into high-value biomass. Based on initial trials by the authors, both species are capable of tolerating wide fluctuations in water salinity (survival up to 90% could be achieved), have fast growth, and command a price about 600–700% higher than *Tilapia*, which has proliferated rapidly since its introduction in the early 1950s. The authors argue that, in addition to converting low-value biomass into high-value fish, the introduction of acclimatized predators would create a new occupation in the coastal zone involving the collection and acclimatization of the fry of the predators being introduced into inland water bodies. However, more biological trials would be necessary before the idea becomes operational. Moreover, it would be necessary to regulate access to the enhanced water bodies and to control efforts so that economic overfishing does not occur, either from overcrowding or from use of fine nets.

Socioeconomic Conditions

Socioeconomic Conditions of Small-Scale Fishermen: A Conceptual Framework

Theodore Panayotou

A study of the socioeconomic conditions of small-scale fishermen is a prerequisite to the design and implementation of effective assistance programs. The purpose of such a study is threefold:

- To provide an overall picture of the structure, activities, and standards of living of small-scale fishing communities and households as a background to more in-depth analysis;
- To compare the standards of living of small-scale fishing households to those of other socioeconomic groups (e.g., farmers), and to the national average to determine their relative positions in the national economy and establish whether government intervention to upgrade their position is needed; and
- To identify factors that account for differences in standards of living among small-scale fishing households themselves and between them and other socioeconomic groups so that effective policies for assistance and development can be formulated and recommended.

Indicators of Living Standards

The basic unit of analysis is the household but the community must also be considered because public services, systems of social sharing, and the general environment of the community affect the welfare of the individual household. The basic dependent variable (i.e., the fact to be explained) is the standard of living of the fishing household. First, however, it must be defined and measured. The most commonly used and manageable, although not always satisfactory, measure of standard of living is household income from all sources (fishing and nonfishing) and in all forms (cash and noncash) whether earned by the head of household or other family members. For comparison purposes, the net disposable income per person (rather than gross household income) is used; that is, depreciation charges and taxes should be deducted and subsidies added to gross income and the family size and age structure taken into account. Moreover, adjustments for differences in the cost of living between communities should be made (cross-section deflation).

Even after all these adjustments are made, income may still not be a satisfactory index of welfare, especially in subsistence communities. Alternative measures of living standard range from consumption levels, in value or volume, to nutritional status and from possession of consumer durables including type of living quarters to the physical quality of life index (PQLI). The latter is a combination of such variables as education level, life expectancy, and child mortality and is more suited to comparisons between communities rather than households. Another frequently used indicator of living standards is the Engel's coefficient, which is defined as the ratio of expenditure on food to total expenditure. It can be used both as an absolute measure of welfare as well as for comparitive purposes. The larger the percentage of total expenditure going to food, the poorer the household is considered to be.

Because none of the above indicators is perfect, one may choose to use a combination such as income, Engel's coefficient, education levels, and consumer durables. A problem of choice or weighting arises when radically different results are obtained by the different measures. Another complication relates to the fact that households in different communities may enjoy different levels of such public services as water supply, electricity, and telephone and such social amenities as community centres, temples, and places of entertainment. Thus, a comparison at the community level is also necessary.

Once we determine the standards of living of the fishing households in absolute terms, as well as vis-à-vis each other, we would like to know how fishing households compare with other groups in the country because nobody can be said to be rich or poor except by comparison to others or at least to some arbitrarily defined poverty line. If the government has established a poverty line, usually in terms of income level, with the objective of assisting those below it, it would be meaningful to determine whether small-scale fishing households, or some subset of them, fall below the poverty line. Similarly, it would be worthwhile to compare the small-scale fishermen's standard of living to the national average (e.g., to the country's per-capita income if the comparison is in terms of income).

However, more meaningful comparisons can be made with comparable socioeconomic groups such as farming households, large-scale fishing households, and rural households in the region or province where the small-scale fishing households are located. In the case of fishing-labour households, comparison can be made with other hired-labour households in the area. In making these comparisons, the same definition of income (or other measure of living standard) should be used, with all necessary adjustments (family size, cost of living, tax, amenities, etc.) and due allowance for a margin of error arising from differences in methodology of data collection and level of precision.

Thus, in attempting to define and measure standard of living, it is necessary to describe, in a meaningful, comparative way, several of the conventional socioeconomic variables: occupational structure, family size and age structure, cash and noncash income, consumption expenditure, education, house and other consumer durables, public services, and social amenities. These variables are described and measured not for their own sake but because they are needed to establish how well-off the fishermen are vis-à-vis each other and the rest of the country. We are then able to say whether the small-scale fishery sector as a whole, or some part of it, is among those groups of the society that need special government attention and assistance. Attempts should also be made to determine whether the fishermen's current (relative) income position, whether high or low, is not a temporary feature, i.e., we should introduce some historical perspective into the picture. Moreover, even if the past confirms the present, there is no reason why the future should be the same:

some consideration of future prospects, especially in the light of growing population, expanding economy, rising unemployment elsewhere, or resource depletion in the immediate area, should all be taken into account.

Sources of Income Differentials

The next step is to determine what general form government intervention should take. Should the government provide small-scale fishermen with credit and subsidies to enlarge their boats or to buy land and farming equipment; help them extend their fishing range to new fishing grounds or assist them in expanding their nonfishing activities; encourage more labour-intensive fishing technology and fish processing at home; or develop more nonfishing employment opportunities. To answer questions of this sort, we need to determine what factors account for income differences among fishing households themselves and between them and other socioeconomic groups.

In a private enterprise system, income is derived mainly from the ownership of factors of production: labour, capital, and natural resources. (Income may also be obtained through government transfer payments, social sharing, and charity but these are exceptions rather than the rule.) Fishing income in particular is derived from the ownership of such fishing assets as boat, engine, and fishing gear; from the employment of household members on the household's fishing boat or on other boats in return for a wage or a share of the earnings, or both; and from the ownership or access to the fishery resource that is capable of yielding resource rents. Nonfishing income, on the other hand, is derived from the ownership or access to land[1] capable of yielding a rent over and above the cost of production; from the ownership of farm and other nonfishing assets such as buildings and transport vehicles as well as access to operating capital; and from the employment of household members on their own farm or as hired labour in other farms, in civil service, or in industry. Thus, the household's total income (equation [4]) may be expressed as:

$$Y = Y_F + Y_N \qquad [1]$$
$$Y_F = Y_F(K_F, L_F, R) \qquad [2]$$
$$Y_N = Y_N(K_N, L_N, T) \qquad [3]$$
$$Y = Y(K_F, K_N, L_F, L_N, R, T) \qquad [4]$$

Where Y_F is fishing income; Y_N is nonfishing income; R is the fishery resource, a location-specific variable that can take the values 0 and 1 in distinguishing between two locations; K_F and K_N represent the value of fishing and nonfishing assets respectively; L_F and L_N represent fishing and nonfishing man-days worked by family members respectively; and T denotes ownership of land in hectares (adjusted for quality). Equation [4] may be further specified as:

$$\ln Y = a_0 + a_F \ln K_F + a_N \ln K_N + b_F \ln L_F + b_N \ln L_N + c_N \ln T + c_F \ln R \qquad [5]$$

Equation [5] can be estimated using sample data and linear regression techniques such as ordinary least squares. The estimated values of the parameters a, b, and c are the production (income) elasticities of the various factors of production. They tell us the percentage increase in income resulting from a 1% increase in one factor of production while all others are held

[1]Access to land may be through share cropping, tenancy, or encroachment of public land in forest and mangrove areas.

constant. For example, a_N indicates the percentage increase in income due to a 1% increase in the size of the vessel and engine (or the catching power of the vessel). This may be compared with the effect on income of an equal capital expenditure on upgrading nonfishing assets, for example, the purchase of additional farming implements.

Similarly, b_F indicates the percentage increase in the household income due to a 1% increase in the number of man-days devoted by the household to fishing activities. This may be compared with b_N, the effect on income of an equal percentage increase in the number of man-days devoted to nonfishing activities. As the size, age structure, and sex composition of a household and the educational level of its members affect the amount and type of work that the household is able to undertake, dummy variables may be introduced to stratify households into various groups and examine the effect of sociodemographic variables on the household's earning capability. Similarly, we may introduce institutional factors ranging from religious differences to different land tenures or regulation of access to fishery resources. Moreover, fishermen may have been locked into an unfavourable position by past decisions to purchase a certain type of vessel or gear that, due to changes in resource availability or composition, is not profitable at present. In such cases, dummy variables to represent different types of gear may be introduced. With respect to the fishery resource, there may be differences in productivity among similar gears if they operate in different locations or even in the same location if there are quasi-property rights in particular high-productivity sites, as is often the case with stationary gear.

Depending on which factors are found to contribute more to family income, the government can design its intervention policies so as to achieve the maximum effect on the small-scale fishing household's income from a given level of public expenditure. The optimum policy will often be one of a mixture of policy instruments such as promotion of both labour-intensive fishing technology as well as creation of nonfishing employment opportunities; or helping fishermen to convert their vessels into more profitable types of gear as well as helping them to move gradually out of the fishing occupation. The above analysis will help select the most appropriate mix of such policies.

A More Analytical Formulation

The foregoing exposition is only one example of how to enhance the analytical content and policy relevance of socioeconomic research on small-scale fisheries research. The analysis may be more detailed and a finer breakdown of income and its explanatory variables and a less ad hoc formulation can be chosen. For instance, we may want to keep fishing income separate from nonfishing income and specify it as:

$$Y_F = PQ(X_i, Z) - C_iX_i \qquad [6]$$

Where P = price of fish; Q = quantity of fish caught; X_i = quantity of purchased fishing input i; Z = quantity of owned inputs (of family labour); and C_i = unit cost of fishing input i.

However, data availability might be a problem in certain cases. When data are available or could be obtained at reasonable cost, a detailed profitability and production-function analysis, as summarized in equation [6], could be carried out to determine how profitable and productive are different fishing gears operating in different locations. Fishing income differentials arise from differences in fish prices, fishing costs, and catch, which could be identified and measured by a detailed cost and earnings or profitability study (the second section of this volume). Catch differences may then be related to and explained by differences in fishing technology, input use, and fishery resource abundance as well as in the efficiency with which these are combined (third section).

Price and cost differences may be related to and explained by market structure, market distortions and inefficiencies, transport costs, (dis)economies of scale, etc. (fourth section). Differences in technology and in access to resources and markets may in turn be related to social and institutional constraints such as caste restrictions, religious beliefs, taboos, and customary property rights (fifth section). In the light of the findings of these investigations, government policies aimed at assisting small-scale fishermen can be evaluated (sixth section) and alternative policies recommended. Given the definite limits of natural fisheries in providing income and fish supplies to growing populations, the need to develop alternative sources is inevitable. Among the various alternatives, aquaculture (discussed in the seventh section) has a particular appeal because it could provide both income and fish supplies and, in many cases, it could be developed in the vicinity of fishing communities, thus saving in relocation costs.

Socioeconomic Conditions of Small-Scale Fishermen and Fish Farmers in the Philippines

Aida R. Librero, Rebecca F. Catalla, and Rita M. Fabro[1]

Fisheries contribute nearly 5% of the gross national product of the Philippines and provide employment to about 4% of the country's labour force. The industry consists of three sectors: the large-scale or commercial capture fishery, the small-scale or municipal capture fishery, and aquaculture.

The municipal fishery, which is regarded as the most important sector in Philippine fisheries, is a major source of fish and provides employment for a significant portion of the rural population. In 1978, the catch from municipal fishing accounted for 60% of total fish output. Because it is an extremely labour-intensive occupation, the municipal fishing sector provides direct employment to over 0.5 million people along the coastal areas of the country. Based on a 1977 inventory of fishing units,[2] 54% of fishermen in the Philippines were engaged in full-time fishing activities, 30% were part-time, and 16% fished occasionally. In addition, the municipal fisheries provide employment indirectly through fish marketing and distribution, fish processing, net making, and boat construction.

Despite this substantial contribution of the municipal fishery to the national economy, until recently this sector had received only scant support from the government. The standard of living of municipal fishermen appears to be low both in absolute terms and by comparison to the living standards of other rural inhabitants. However, the necessary information for the formulation of government assistance programs is lacking.

The purpose of this study was to provide such information through surveys and description of the absolute and relative socioeconomic conditions of municipal fishermen and of fish farmers, whose numbers have been increasing rapidly in recent years. Thus, the paper consists of two main parts. The first, which follows a brief description of the sampling methodology, attempts to describe the socioeconomic conditions of municipal fishermen and fish-pond operators, with emphasis on education, employment, and income levels from fishing and nonfishing activities. The second part provides a comparison of the standards of living and other socioeconomic conditions of fishermen and fish farmers with those of rice and coconut farmers: rice is the major food crop in the Philippines and coconut is the major export crop.

Sampling Methodology

A survey of 506 municipal fishermen and 197 fish farmers was conducted from April to June 1979 in eight regions of the country: Ilocos (Region I), Central Luzon (III), Southern Tagalog (IV), Bicol (V), Western Visayas (VI), Central Visayas (VII), and Northern (X) and Southern Mindanao (XI) (Fig. 1).

A multistage sampling technique was used to select sample respondents. From the list of fishermen and fish farmers who had borrowed from the Development Bank of the Philippines (DBP), eight regions with the largest number of

[1]We thank the International Development Research Centre for their financial support; the Development Bank of the Philippines and the Bureau of Fisheries and Aquatic Resources (Philippines) for providing the sampling frame and identifying the respondents for the project; the Philippine Council for Agriculture and Resources Research for providing the logistical and administrative support; other researchers and staff of the project who participated in interviewing respondents and analyzing the data; and the fishermen and fish-pond operators who unselfishly responded to our many questions.

[2]A joint project of the Bureau of Fisheries and Aquatic Resources, Fishery Industry Development Council, and Bureau of Agricultural Economics.

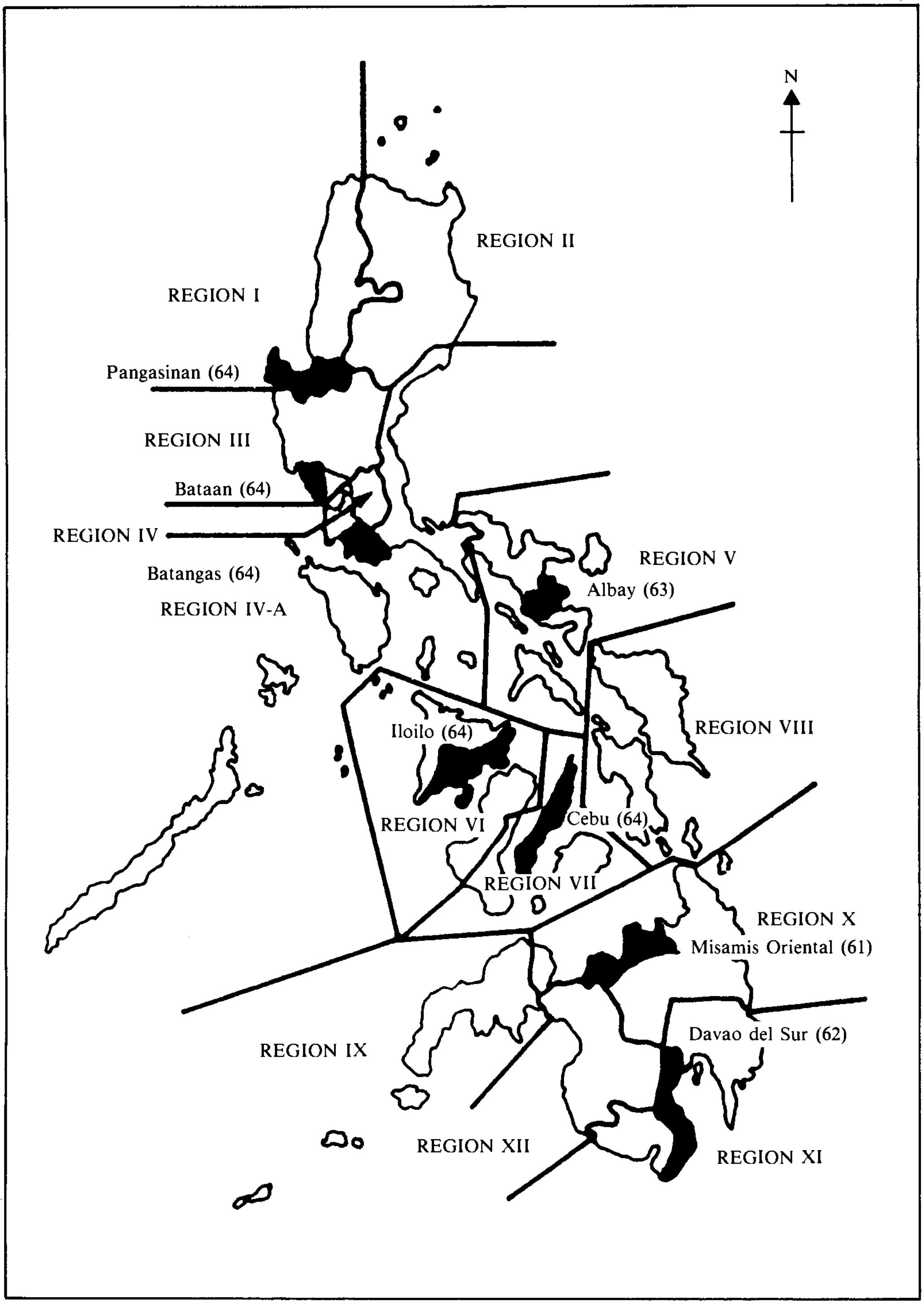

Fig. 1. *The Philippines showing sampled areas (shaded) and sample sizes (values in parentheses).*

borrowers were chosen. A random sample of fishermen and fish farmers was then taken from the province with the largest number of borrowers within each of the eight regions. The sample included both borrowers and non-borrowers because the thrust of the overall project was to study the effect of the credit scheme on technology, investment, and socioeconomic conditions of small-scale fishermen and fish farmers.

For an in-depth analysis of the fishing operations and the various cash inflows and outflows in fishing households, a sample of 59 fishermen was later selected from two sample provinces, Batangas and Bataan. The fishermen within the subsample were asked to keep records of daily catch, fishing effort, receipts, and expenditures for 1 year.

Absolute Socioeconomic Conditions

Socioeconomic profile

The average age of the fishermen was 40 years and this varied only slightly among regions with the youngest coming from Southern Tagalog and Western Visayas and the oldest from Ilocos (Table 1). On the average, the fishermen had spent about half of their lifetime in fishing, with Bicol fishermen devoting 24 years of their lives to this occupation. Although most fishermen had received some education, the level attained was relatively low, only 5.3 years. The educational level was highest among the young fishermen of Western Visayas where 16% had gone to college. In Central Luzon, more than 65% of the fishermen had reached high school.

Fish farmers were older than the fishermen, with an average age of 53 years, but they had somewhat less experience in their occupation than fishermen. In terms of educational attainment, 44% of the fish farmers had reached the college level, whereas 22% and 29% have had secondary and elementary education, respectively. On the average, a fish-farm operator acquired almost 10 years of formal education or had reached at least the 4th year of high school. The high educational attainment among the fish farmers was particularly evident in Bicol where the average fish farmer had 11 years of education (Table 1).

Comparatively, the level of education attained by fish farmers was not much different from that of other fish producers. Fish-pen operators from Laguna de Bay had practically the same educational level as the fish farmers (Nicolas et al. 1979). However, the lowest level of schooling was found among the caretakers (Nicolas and Librero 1980) and the fry gatherers (Librero et al. 1976). In terms of experience, the fishermen had spent more years in fishing activities than the fish-pen and fish-farm operators.

Labour use and sharing arrangements

About 80% of the municipal fishermen studied were boat owners, 6% were boat renters, and 14% were fishermen labourers or shareworkers. As the name implies, a boat owner owns a boat, which may be motorized or nonmotorized. A boat renter operates independently of the boat owner and pays a certain amount, either on a fixed rate or as a percentage of gross or net income, to the boat owner. A shareworker works with a boat owner or a boat renter and is paid either a fixed rate or a percentage of gross or net income.

Table 1. Sociodemographic characteristics of fishermen and fish farmers, Philippines, 1979.

Region	Fishermen					Fish farmers				
	Sample size	Average age (years)	Experience (years)	Non-educated (%)	Years of schooling	Sample size	Average age (years)	Experience (years)	Non-educated (%)	Years of schooling
Luzon	**255**	**40**	**21**	**3**	**5.5**	**108**	**53**	**19**	**4**	**9.4**
Ilocos	64	42	21	2	5.7	40	53	19	5	7.6
Central Luzon	64	39	21	3	5.9	38	56	23	3	10.1
Southern Tagalog	64	37	19	6	4.7	17	52	18	6	10.8
Bicol	63	41	24	3	5.7	13	45	11	0	11.1
Visayas	**128**	**40**	**17**	**15**	**5.2**	**50**	**54**	**18**	**8**	**9.4**
Western	64	38	16	9	6.5	40	55	19	8	9.0
Central	64	42	18	20	3.8	10	49	12	10	10.9
Mindanao	**123**	**41**	**21**	**2**	**5.0**	**39**	**53**	**15**	**2**	**10.9**
Northern	61	41	21	2	5.8	19	55	19	5	10.8
Southern	62	41	21	3	4.2	20	51	12	0	11.0
All regions	**506**	**40**	**20**	**6**	**5.3**	**197**	**53**	**18**	**5**	**9.7**

The extent of labour use in municipal fishing is clear from the numbers of fishermen comprising a fishing unit (range from 1 to 16): 49% of the sample had two or three fishermen and another 15% had at least four members, the remaining 36% were single-fishermen operations (see Table 3). The average crew for boat owners was composed of two members whereas that of the boat renters was three fishermen. The shareworkers, on the other hand, were employed in fishing units with a crew of four fishermen. However, a significant proportion, 44%, of boat owners employed at least four other fishermen to assist them in their fishing activities.

In terms of time allocation between fishing and nonfishing activities, the fishermen went on fishing expeditions four or five times each week and spent the remaining 2 or 3 days resting or working in secondary or subsidiary occupations. On the average, they spent 8 hours for each fishing trip. In a year, a fishing unit averaged 211 fishing trips. Based on daily records kept by fishermen in two provinces, fish capture and fishing-related activities (e.g., bait preparation, marketing, boat and engine repair, and net mending) took 177 and 23 days, respectively of the fishermen's time (Table 2). A further 35 days were devoted to nonfishing income-generating activities such as boat construction, working as fish-pond or fish-pen labourers, and farming. The fishermen were idle for 4.4 months or 36% of the time, implying a high incidence of underemployment.

Fishing income was generally received as a percentage share of net income. More than 50% of the fishermen with hired labourers divided the net earnings equally between fishing equipment and fishermen, whereas 14% utilized a 40/60 system, that is 40% went to the boat and gear and 60% to the fishermen. Another 14% used a one-third/two-thirds sharing system.

Some boat owners received a fixed payment, which amounted to 2.5 PHP/day for a rented nonmotorized boat, 2 PHP/day for the rent of catching gear, and 50 PHP/month for a rented engine (in 1979, 7.40 pesos [PHP] = US$1). However, several variations of method of payment existed:

- A master fisherman might be paid the equivalent of 10% of the gross sales after which the net income and the share of the fishing equipment and the crew members (including the master fisherman) are computed;
- In the *pasahero* (passenger) system, a fisherman who owned his own gear went on fishing trips with a boat owner but caught fish independently from the crew of the fishing unit and, at the end of the day, paid a certain percentage (either 30% or 50%) of the gross value of his catch to the boat owner.

Table 2. Labour allocation and average daily income from fishing based on a sample of 27 small-scale fishermen in Bataan and Batangas, Philippines, 1979–80.

	Number of days spent —				Income from fishing (PHP/day)[b]			
Month	Fishing	Fishing-related activities[a]	Other occupation	Leisure or idleness	Gross income	Cost	Net income	Standard deviation of net income
				1979				
May	15.8	1.8	2.2	11.2	84.73	47.52	37.21	11.49
June	13.0	1.5	2.8	12.7	85.43	45.97	39.46	12.93
July	15.1	2.9	2.3	10.8	84.86	46.04	38.82	11.19
August	13.4	1.4	3.2	13.0	98.31	48.47	49.84	15.16
September	17.0	2.1	3.0	7.8	91.18	51.39	39.79	12.29
October	15.8	2.1	3.0	10.2	98.88	53.45	45.43	10.45
November	15.5	1.8	3.6	9.2	115.20	52.31	62.89	16.06
December	14.2	2.2	3.3	11.3	116.21	57.88	58.33	21.78
				1980				
January	14.8	2.0	3.3	10.9	126.92	63.29	63.63	13.68
February	14.8	1.6	2.3	10.3	132.13	69.20	62.93	17.12
March	13.1	1.6	2.3	14.0	106.73	65.88	40.85	21.36
April	14.4	1.7	3.9	10.0	119.71	69.71	50.00	13.65
Total	176.6	22.7	35.2	131.4	1260.28	671.11	589.18	–
Average	14.7	1.9	2.9	10.9	105.02	55.93	49.10	17.83

[a]Includes bait preparation, net mending, and boat and engine repair.
[b]In 1979, 7.40 pesos (PHP) = US$1.

Table 3. Annual value of share of fishing equipment and fishermen by type of fishing operation, Philippines, 1979.

	Number reporting (fishing units)	Net income[a] (PHP)[b]	Share of boat and gear (PHP)	Share of fishermen		
				Number (persons)	Total (PHP)	Average (PHP)
Boat owner	**405**	**5287**	**1246**	**2.10**	**4041**	**1911**
Working alone	169	3840	–	1.00	3840	3840
With family members	50	3910	–	2.34	3910	1971
With other fishermen	177	6960	2682	3.05	4278	1403
Nonoperating	9	7258	3361	2.89	3897	1348
Boat renters	**30**	**5018**	**1843**	**2.80**	**3175**	**1134**
Working alone	11	3589	815	1.00	2774	2774
With family members	5	4982	1284	2.00	3698	1849
With other fishermen	14	6153	2850	4.50	3303	734
Share workers	**70**	**9810**	**3948**	**3.90**	**5862**	**1503**
All fishermen	**505**	**5899**	**1657**	**2.47**[b]	**4242**	**1717**

[a]Net income is defined here as gross income minus operating expenses other than labour costs.
[b]In 1979, 7.40 pesos (PHP) = US$1.
[c]Of the sampled fishing units, 36% employed only one fisherman (often the owner himself), 25% employed two fishermen, 24% employed three fishermen, and only 15% employed more than three.

Income levels and variations

In the survey of incomes received by fishing units and by fishermen for various types of arrangements, most of the fishermen (80%) owned boats (Table 3). Of these, 44% had other fishermen working with them whereas 42% worked alone. A fisherman working alone or with his family receives the total income from fishing but he also shoulders all the expenses. If he owns the boat and gear and at the same time goes out with others, he gets the share of the equipment and his share as a crew member. This share is generally based on the gross sales less the expenses during a fishing trip. Such expenses include gasoline, oil, kerosene for the lamp, and food but exclude depreciation and the opportunity cost of capital. Hence, the share of equipment is gross of depreciation and, in that sense, the net income of boat owners is overestimated by the amount of depreciation.

On the average, a fishing unit grossed an annual income of 10 295 PHP (US$1391). After deducting operating expenses, net income amounted to 5898 PHP (US$797) of which 28% was the share of the fishing equipment. The average 2.5 fishermen comprising a fishing unit shared the remaining 72%. Each of the fishermen, therefore, received an annual net share of 1717 PHP (US$232) (Table 3). This amount, however, does not constitute the fisherman's total net income from fishing. A fisherman may own a boat or gear and his crew may be members of his family.

Fishing incomes vary widely from day to day: gross incomes varied by 200% from one day to the next and variations in expenditures and incomes of 100% were not unusual. In contrast, the variation of daily net income is limited when averaged over a month although there appears to be a seasonal trend with a peak during November to February and a trough during May to July. In fact, the gross income was below the daily average of 105 PHP for the entire monsoon period from May to October when fishing is affected by heavy rains, typhoons, and strong winds.

For most of the daily observations, gross earnings and costs incurred were positively related. Thus, when the gross income was high,

Table 4. Fishermen's nonfishing employment and income, Philippines, 1978–79.

Nonfishing employment	Number reporting	Percent of subsample	Annual income (PHP/ fisherman)[a]
Total	**107**[b]	–	**2348**
Labouring	35	33	1194
Business	24	22	2395
Carpentry	18	17	2385
Farming	15	14	1248
Driving	9	8	3664
Others[c]	12	11	3631

[a]In 1979, 7.40 pesos (PHP) = US$1.
[b]Some fishermen reported more than one nonfishing occupation.
[c]Includes haircutting, fry marketing, welding, livestock farming, and net making.

Table 5. Annual income from all sources of fishing households by status and business practice, Philippines, 1978–79.

	Number of respondents	Fisherman's net earnings[a] (PHP)	Total other income (PHP)	Family income from all sources (PHP)
Boat owners	**405**	**4008**	**2382**	**6390**
Working alone	169	3691	1600	5291
With family members	50	3910	1524	5434
With other fishermen	177	4372	2932	7304
Nonsea-going boat owners	9	3328	10147	13475
Boat renters	**30**	**2243**	**1872**	**4115**
Working alone	11	2774	2632	5406
With family members	5	3698	974	4672
With other fishermen	14	1306	1598	2904
Share workers	**70**	**2004**	**2356**	**4360**
All fishermen	**505**	**3625**	**2348**	**5973**

[a]Total revenue minus cash operating and marketing costs. In 1979, 7.40 pesos (PHP) = US$1.

the expenditures were also high and vice versa. Fishermen generally incurred higher cost on days of high gross receipts due mainly to the added cost of marketing. Daily expenditures averaged 56 PHP or 53% of gross receipts whereas net income averaged 49 PHP or 47% of gross receipts.

To augment the income derived from fishing, 21% of the 506 fishermen interviewed earned from other occupations between fishing days. These included working as labourers in fish ponds, small factories, or sea ports; engaging in small-scale business (grocery or *sari-sari* store); and buying and selling various agricultural and fishery products (Table 4). On the average, these nonfishing income-generating activities earned them an additional 2348 PHP: the highest amount (5791 PHP) was earned by the nonsea-going boat owners[3] and the lowest amount (988 PHP) was earned by fishermen working with other family members. The earnings of the boat owners from nonfishing occupations were 27% higher than the earnings of boat renters (Table 5).

Including the income from all sources, average family income was 5973 PHP/fishing household per year: of this, 59% came from the fish-capture activities (Table 5). Boat owners' income from fishing and from other sources was higher than that of boat renters and share-workers. Of the latter two groups, the share-workers earned an income 6% higher than the boat renters. From fishing activities, the highest amount (4372 PHP) was earned by the boat owners who worked with other fishermen and the lowest (1306 PHP) by boat renters who fished with other fishermen. Income from all sources was highest (13475 PHP) for the nonsea-going boat owners. This may be ascribed to the fact that they had more time to devote to income-generating activities other than fishing. For fish farmers, income from all sources was about 51 500 PHP or more than eight times higher than that earned from all sources by fishermen. (Table 6).

[3]A nonsea-going "fisherman" is one who owns a boat but does not go out fishing. Instead, he rents it out to fishermen.

Comparative Socioeconomic Conditions

For a deeper appreciation of the socioeconomic conditions of municipal fishermen and fish farmers, it is necessary to compare their income levels and other indicators of living standards to those of other rural socioeconomic groups, and to the national average.

As in most developing countries, the Philippine economy may be characterized as a basically rural economy, heavily dependent on its agricultural sector. Necessarily, agriculture accounts for a significant portion of the total income generated in the rural areas. Such income is derived mainly from food crops such as rice and corn, from fish and livestock, and from commercial crops, which include coconuts and sugarcane.

To compare and assess the prevailing socioeconomic conditions among rural households, four occupational groups were studied: municipal fishermen, fish farmers, rice farmers, and coconut farmers. Several indicators, including income and expenditure levels, ownership of residential lots and homes, and availability of basic home utilities, were considered. Quantitative data were obtained from both the present and previous studies. Because these studies were

Table 6. Annual income of fish-pond operators and their households by region, Philippines, 1978–79.

Region	Number of farms[a]	Income per fish farm (PHP)[b] From farm activities	From nonfarm activities	From economically active household members	Household total	Average household size (persons)	Income per person (PHP)
Luzon							
Ilocos	39	13557	1811	2677	18046	5.97	3023
Central Luzon	37	41579	9778	13613	64970	5.38	12076
Southern Tagalog	17	25154	9099	5900	40153	5.18	7752
Bicol	11	97078	16420	4782	118280	5.09	23238
Visayas							
Western	40	43756	6119	4051	53926	5.05	10678
Central	10	10715	7739	12736	31190	5.30	5885
Mindanao							
Northern	19	35025	22197	11210	68432	4.74	14437
Southern	20	28686	24250	600	53536	5.75	9311
Philippines	**193**	**34504**	**10397**	**6608**	**51509**	**5.37**	**9952**

[a]Fish farms with no crop in 1978–79 were excluded.
[b]In 1979, 7.40 pesos (PHP) = US$1.

conducted in different years, the consumer price index was used to adjust price changes and make the data comparable. Several measures were used: income from the main occupation and from the secondary occupation, total household income, total expenditures, and expenditure on food.

Relative income levels

For the country as a whole, the standard of living of municipal fishermen, as measured by their net household income from all sources, 5000 PHP, was similar to that of crop farmers falling between the incomes of the rice farmers, 3500 PHP, and the coconut farmers, 5900 PHP (Table 7). However, the fishing household's income was considerably lower than the rural average of 6900 PHP, and the national average of 8500 PHP.

There were considerable differences between regions. Fishing incomes in Luzon were almost double the crop-farming incomes and more in line with the rural average for the country as a whole. In Mindanao, fishing incomes were similar to both crop-farming incomes and the rural average whereas the Visayas fishermen's incomes, 1600 PHP, were a small fraction of both the regional crop-farming incomes and the rural average income of the country. In contrast, the incomes of fish-farming households, over 25 000 PHP, were a multiple of crop-farming and fishing incomes as well as of the rural and national averages. A similar picture prevailed regionally except that income differentials were highest in the Visayas where the fish-farming households had an average income of 48 000 PHP, which was 30 times the average fishing household's income and more than five times the national average.

Food expenditure and amenities

As it may not be entirely appropriate to measure standard of living by income alone, two further indicators are examined: the expenditure on food as a proportion of total expenditure, known as the Engel's coefficient; and the access to amenities such as electricity, water supply, and other household facilities.

Food accounted for over half of the total outlay of fishing and farming households, with the remaining outlay going on such items as education, clothing, medical assistance, and home improvements (Table 8). The Engel's coefficient for fishing households in Luzon (for which data were available) was 0.59 compared to the regional coefficients of 0.51 and 0.52 and the national coefficients of 0.44 and 0.49 for rice farmers and coconut farmers respectively. This is contrary to what we would expect because fishing incomes in Luzon were, on the average, considerably higher than crop-farming incomes in the same region (Table 7). As expected, however, the Engel's coefficient is higher for boat renters and shareworkers than for boat owners who had a higher income. Compared to an Engel's coefficient of 0.57 for the nation as a whole, the coefficient for the Luzon fishing

Table 7. Comparative income levels (PHP)[a] of fishing, fish-farming, and crop-farming households, Philippines, 1979.

Region and socioeconomic group	Net income[b] from — Main occupation: Household head	Main occupation: Other members	Secondary occupations: Household head	Secondary occupations: Other members	Household net income from all sources
			Luzon		
Fishermen	**3008**	**316**	**478**	**1874**	**5676**
Boat owners	3150	278	457	2024	5909
Nonowners[c]	2370	472	131	1256	4229
Fish farmers	**7892**	**1983**	**7201**	–[d]	**17076**
Pond owners	10328	2302	9373	–	22003
Caretakers	6127	1861	2697	–	10685
Crop farmers					
Rice farmers	455	1	1959	524	2939
Coconut farmers	220	56	2418	1613	4307
			Visayas		
Fishermen	**333**	**41**	**363**	**910**	**1647**
Boat owners	289	42	429	1069	1829
Nonowners	574	35	23	98	730
Fish farmers	**7938**	**8735**	**31717**	–	**48390**
Pond owners	13230	10539	42915	–	66684
Caretakers	4307	1308	1896	–	7511
Crop farmers					
Rice farmers	730	32	2094	1545	4401
Coconut farmers	854	166	4245	1863	7128
			Mindanao		
Fishermen	**2959**	**434**	**840**	**1670**	**5903**
Boat owners	3033	340	530	1606	5509
Nonowners	2628	739	1845	1756	6968
Fish farmers	**10622**	**2622**	**9511**	–	**22755**
Pond owners	24374	3834	15611	–	43819
Caretakers	4348	1321	1915	–	7584
Crop farmers					
Rice farmers	–	–	–	–	–
Coconut farmers	1727	420	2414	1664	6225
			Philippines		
Fishermen	**2646**	**275**	**492**	**1581**	**4994**
Boat owners	2974	230	466	1675	5345
Nonowners	2127	458	596	1157	4338
Fish farmer	**8241**	**3691**	**13532**	–	**25464**
Pond owners	12476	4733	19277	–	36486
Caretakers	5511	1674	2426	–	9611
Crop farmers					
Rice farmers	564	13	2013	930	3520
Coconut farmers	969	233	3050	1696	5948

Sources: Fishing, present study; fish farming, Librero et al. (1977); rice farming, Socioeconomic studies, Special Studies Division, Ministry of Agriculture, 1975–79; Coconut farming, Valiento et al. (1979).

[a]In 1979, 7.40 pesos (PHP) = US$1.

[b]Net income is defined as total revenues minus total costs throughout Table 7 resulting in lower values than those given in Tables 4 and 5.

[c]Includes boat renters and shareworkers.

[d]Dash indicates data not available.

household appears reasonable, especially because the former includes beverages and tobacco whereas the latter does not.

Ownership of the residential lot (Table 9) was higher for fish farmers (about 80%) than for fishermen (about 20%) or for rice farmers (about 75%) and incidence of renting or of squatting on residential lots was high among fishing households. However, in the groups studied, ownership of a residential lot was above 50%.

In the early 1970s, only 23% of the households in the country were using electricity as a source

Table 8. Expenditure, Engel's coefficients, and savings of fishing and farming households, Philippines, 1979.

Region and socioeconomic group	Total household expenditure (PHP)[a]	Expenditure on food (PHP)	Engel's coefficient	Household savings (PHP)
		Luzon		
Fishing	7361	4314	0.59	1765
Boat owners	*7918*	*4609*	*0.58*	*2064*
Nonowners[b]	*4629*	*2868*	*0.62*	*300*
Rice farming	3334	1446	0.51	424
Coconut farming	5351	2398	0.52	870
		Philippines		
Rice farming	3598	1416	0.44	432
Coconut farming	6720	3284	0.49	1606

[a]In 1979, 7.40 pesos (PHP) = US$1.
[b]Includes boat renters and shareworkers.

Table 9. Comparative indicators of standards of living of rural households, Philippines.

Type of household	Ownership of residential lot (%)	Electricity (%)	Piped water supply (%)	Toilet facilities (water sealed) (%)
		Fishing households (1979)		
Luzon	27	34	7	7
Visayas	19	5	5	27
Mindanao	12	18	20	19
Philippines	21	23	9	15
		Fish-farming households (1979)		
Luzon	77	58	39	75
Visayas	86	47	17	38
Mindanao	77	32	12	33
Philippines	79	53	34	74
		Rice-farming households (1975)		
Luzon	76	7	13	77
Visayas	59	24	13	56
Mindanao	–[a]	–	–	–
Philippines	76	14	13	68
		Rural average (1970)		
Luzon	–	10	10	14
Visayas	–	3	14	10
Mindanao	–	5	9	7
Philippines	–	6	11	11
		National average (1970)		
Philippines	–	23	24	22

Source: PCARR/IDRC Socio-Economics Research Project (1978–79) and NCSO (1970).
[a]Values not available shown by a dash.

of light and 77% depended on kerosene lamps. In 1979, the same percentage (77%) of fishing households were still using kerosene lamps although as many as 53% of the fish-farming households reported using electricity. Fishing households were apparently in a somewhat better position than rice-farming households, of which only 14% had electricity, although this was based on 1975 data. The regional distribution of electricity favoured Luzon fishermen (34%) and fish farmers (58%) and Visayas rice farmers (24%). It is worth noting that only 7% of Luzon rice farmers had electricity.

Water supply for more than 50% of the rural households of the Philippines in 1970 was from rainwater, springs, lakes, and other similar sources. The national average was lower (39%) for these sources, whereas 24% of households had piped water and an even higher proportion used artesian wells. In the mid- and late-1970s, however, an increased number of homes had piped water. Fishing households were found to be considerably below other socioeconomic groups and the national average in terms of piped water supply. Again, fish farmers were considerably above the national average (Table 9).

For cooking facilities, most households used earthen and kerosene stoves in 1971. It is noteworthy that fishing households were still largely using earthen stoves and have not changed from the national and rural norms of 1970.

A significant departure from the rural and national averages was evident in terms of the toilet facilities used by fishing, fish-farming, and rice-farming households. Compared to a 1970 national average of 45% and a rural average of 39% using "closed-pit" and "water-sealed" toilets, only 30% of the fishing households had such facilities by 1979. Surprisingly, in Luzon only 14% of rural households had relatively modern facilities whereas 46% had no facilities at all. In contrast, about 70% of the rice farmers and 75% of the fish farmers had relatively modern toilet facilities (Table 9). A similar picture was obtained with respect to availability of bathroom and other household facilities.

Summary and Conclusions

To understand the socioeconomic conditions of fishermen and fish farmers better, such living conditions as income, expenditure levels, and household facilities were analyzed in comparison to other rural households in the country.

Fishing households had total incomes that were higher than rice-farming households (4994 vs 3727 PHP) but lower than the national average. Their total consumption expenditure was about twice that of rice farmers. Compared to coconut farmers, however, fishing households were slightly worse off in terms of income.

Fish ponds seem to offer a better income-generating activity not only because of their productivity but also because fish farms are usually larger in land area than agricultural crop enterprises. As a result, fish farmers' household income was about seven times that of the rice-farming household and about four times that of the average coconut-farming household.

The income levels and other indicators of well-being differ both among small-scale fishermen and among farmers within a given location and across locations. For fishermen, these differences could be due to the differences in the species of fish caught, quantity of catch, and price of fish. Another factor is the capability to engage in other occupations that, in turn, offer varied wage rates. The extent to which a person can be employed in a nonfishing or farming activity depends on skills and educational attainment. Fishermen and rice farmers, in general, have almost the same level of education. Fish farmers are better educated; moreover, they can afford to send their children to school for higher education.

For fish farmers, differences in income levels and other indicators of well-being within and across regions could be attributed to variations in the sizes of farms, technology, species and prices of fish cultured, and availability of capital. One aspect that should be considered is the seasonality in income receipts. Daily income fluctuates from negative (when regular costs are incurred but catch is negligible) to positive values. A rice farmer would receive income at the time of harvest, one to three times per year, whereas coconut farmers, because of the nature of the crop, expect receipts every 45 days.

It is apparent that the status of the fishermen must be brought above the poverty line. However, because of the open access of the fishery resources, unregulated entry will lead to over-exploitation of such resources and alternative sources of income are hard to find. Under such conditions, reduction of poverty in this sector calls for a general improvement of the environment (fishing and nonfishing) in which small-scale fishermen operate. Among other means, this could include subsidies for inputs used as well as providing opportunities for employment outside the fishing sector. A comprehensive policy for improvement of the conditions of small-scale fishermen should include regulation of entry, upgrading of fishing operations, and development of additional employment opportunities outside the fishing sector.

Small-Scale Fisheries in Peninsular Malaysia: Socioeconomic Profile and Income Distribution

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This paper is based on a study of small-scale fishermen in Peninsular Malaysia who suffer from unemployment, underemployment, and a high incidence of poverty. With the current dearth of data, the main objective of this study was to generate some base-line information for the small-scale fisheries sector in Peninsular Malaysia, particularly its sociodemographic profile and employment, income, and income distribution characteristics.

Survey Methodology

Practical considerations dictated the choice of two states — Perak on the West Coast and Trengganu on the East Coast — in which to survey fishing households (Fig. 1). This choice facilitated interregional comparisons because Perak is typical of the developed prawn-based West Coast fishery whereas Trengganu represents the underdeveloped East Coast fishery.

Under the circumstances, sample surveys were the only feasible method for such a study. Cross-sectional sampling was based upon the population frame provided by the Division of Fisheries. Subsequently, Pantai Remis and Port Weld in Perak and Kuala Trengganu were selected as the survey districts within which fishing households were randomly sampled. Fishermen in both survey areas use a wide variety of fishing gear, ranging from small trawls to handlines, traps, lift nets, cast nets, and shellfish collection. The areas selected for study are more or less representative of the fishing technologies, capital structures, and income levels of small-scale fisheries throughout Peninsular Malaysia.

The sample survey schedule involved the selection of about 150 fishing households from each coast. Each household was initially interviewed to establish basic parameters, such as family size, employment, asset/income position, employment, and mobility, and to determine the nature of fishing inputs used, including crew, boat, engine, nets, and special equipment, and fishing effort. The first survey was, thus, an inventory of the demographic, social, and technological characteristics of the fishing households. However, as a single one-time survey was inadequate for assessing performance, income, costs, and earnings of the fishing units, such data were collected over a period of 2 months. This task was completed during May–June 1979 with weekly visits made by the enumerators to record the catch, revenue, and expenses for each fishing trip.

Sociodemographic Profile

The basic unit of analysis was the fishing household; out of 300 households interviewed, 281 were finally included in the analysis. Table 1 shows the distribution by location and gear type and such characteristics as ethnic background, age, family size, educational attainment, level of training, and employment status of heads of fishing households. Nearly all the fishermen in Kuala Trengganu were Malays whereas all respondents in Port Weld were Chinese. In Pantai Remis, there were both Malays and Chinese.

The sample was dominated (over 60%) by the 31–50 year age group, which is close to the national value, 57%, for the fishing population (Malaysia, Jabatan Perangkaan 1977). The relatively low percentage of fishermen below 20 years appears to suggest that youths are not attracted to fishing. This is consistent with the observed migration of rural youths to urban areas in search of employment.

Average household size is 6.6 and 6.1 persons for the West Coast and East Coast respectively

[1]We acknowledge the assistance of Professor H. Lampe who provided useful insights into the analysis and Sally Lee for her research assistance.

Table 1. Sociodemographic profile of heads of fishing households: Percentage distribution by location and gear type, Peninsular Malaysia, 1979.

	Pantai Remis				Port Weld				Kuala Trengganu		
	Shrimp trawl net (27)[a]	Shellfish collection (7)	Long-lines (11)	Drift net (11)	Shrimp trawl net (56)	Drift net (18)	Shellfish collection (18)	West Coast total (148)	Trawl net (49)	Hand-lines (84)	East Coast total (133)
Ethnic group											
Malay	33	100	36	71	0	0	0	34	100	100	100
Chinese	67	0	64	29	100	100	100	66	0	0	0
Age group (years)											
<31	18	28	28	0	47	33	22	24	35	22	28
31–50	62	63	54	71	46	56	72	61	59	66	63
>50	20	9	18	29	7	11	6	15	6	12	9
Family size											
<6	48	56	44	57	18	17	11	36	55	31	43
>5	52	44	56	43	82	83	89	64	45	69	57
Educational attainment											
<4	33	9	28	29	46	61	56	37	31	43	37
4–6	63	91	54	57	52	28	44	56	61	55	58
7–12	4	0	18	14	2	11	0	7	8	2	5
Fisheries training											
No	89	100	91	100	96	100	100	97	84	94	90
Yes	11	0	9	0	4	0	0	3	16	6	10
Years as fishermen											
<11	26	46	46	29	44	11	33	35	21	9	13
11–20	41	27	27	29	25	45	33	32	35	45	42
>20	33	27	27	42	31	44	34	33	44	46	45
Employment status											
Self-employed (owner-operator)	82	89	100	100	86	100	100	91	41	50	47
Working for wages (non-owner-operator)	18	18	0	0	14	0	0	9	59	50	53

[a]Values in parentheses are sample sizes.

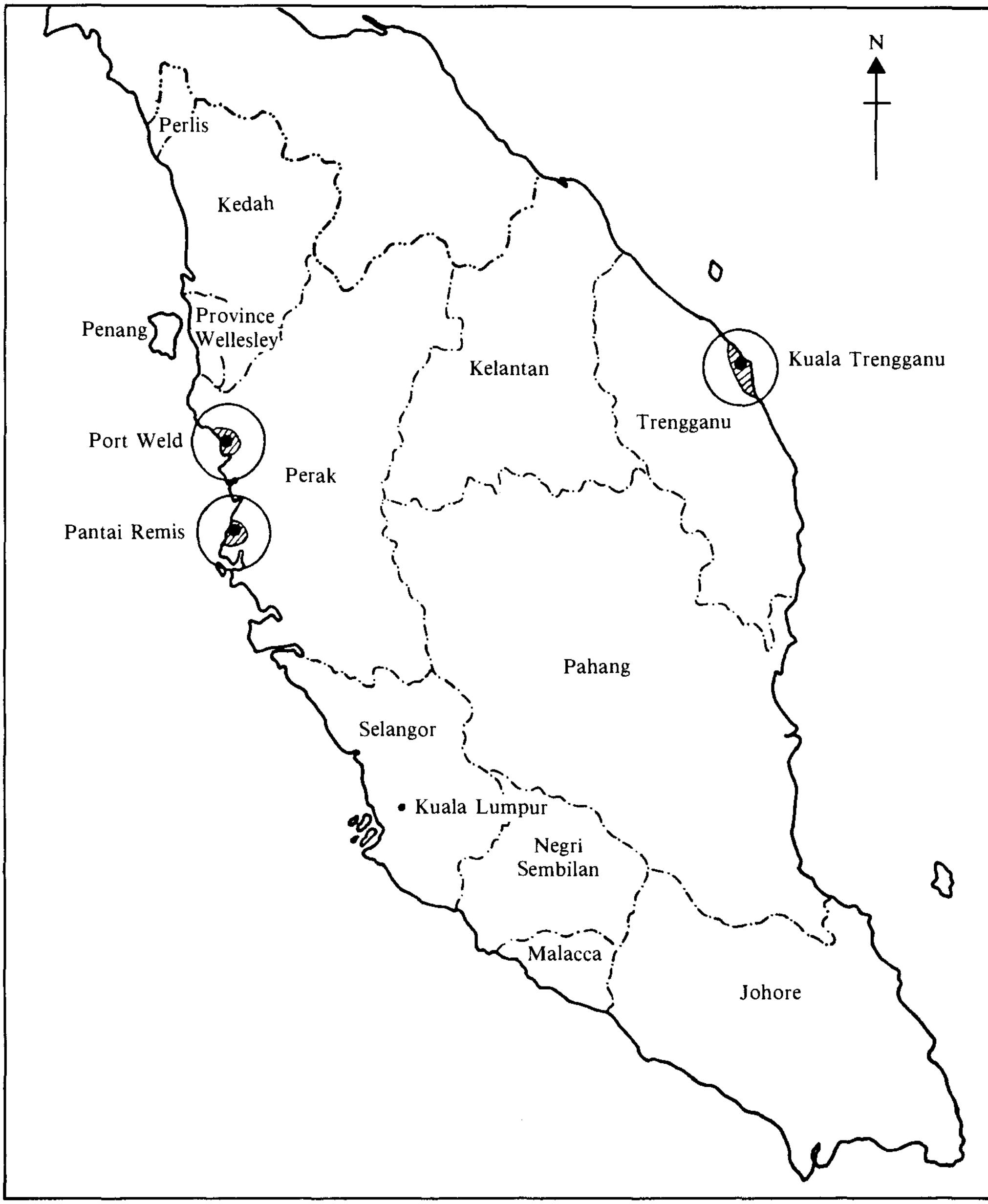

Fig. 1. *Survey areas of the marine fisheries studies, Peninsular Malaysia.*

(Table 2) or slightly higher than the national average of 5.4 persons (Malaysia, Jabatan Perangkaan 1977). However, it varied from 4.9 to 8.5 depending on location.

Although the educational level of the fishing heads of households was low — about 94% of those sampled had at most 6 years of education — the illiteracy level was essentially 0% compared to 33% for the national fishing population. However, few of the fishermen in the sample had any technical training in fishing (Table 1). The fishermen's low educational attainment and the lack of formal training in fishing or in other specialities surely hampers their mobility and lowers their opportunity costs.

Table 2. Selected characteristics of heads of fishing households by location and gear type, Peninsular Malaysia, 1979.

	Pantai Remis				Port Weld				Kuala Trengganu		
	Shrimp trawl net	Shellfish collection	Longlines	Drift net	Shrimp trawl net	Drift net	Shellfish collection	West Coast total	Trawl net	Handlines	East Coast total
Age (years)	41.9	38.4	40.3	45.3	33.8	35.6	37.7	39.0	36.3	38.0	37.2
Family size (persons)	5.6	4.9	6.7	6.0	7.4	8.5	7.3	6.6	5.4	6.8	6.1
Male	2.9	2.6	3.8	3.0	4.1	4.2	3.1	3.4	2.9	3.6	3.3
Female	2.7	2.3	2.9	3.0	3.3	4.3	4.2	3.2	2.5	3.2	2.8
Years of education	4.1	5.5	5.5	4.9	3.4	2.9	2.7	4.1	4.6	3.9	4.3
Fishermen/household	1.1	1.5	1.4	1.9	2.4	2.0	1.3	1.5	1.2	1.2	1.2
Years as fishermen	16.1	15.0	14.9	18.1	15.1	20.3	16.6	16.6	19.3	22.8	21.1

More than 30% of the sample had been fishing for 20 years or longer (Table 1) but the period involved in fishing varied with location and gear type (Table 2). Most fishermen took up fishing at an early age and selected fishing as their main source of income and employment. Alang (1979) noted that only 8 and 26% in Perupok and Seberang Pintasan respectively had other employment before fishing. With the exception of the Port Weld shrimp and drift net fishermen, the average number of fishermen per household was only slightly above one despite the large household size.

The majority of the household heads on the West Coast were self-employed or owner-operators (91%) as opposed to 47% on the East Coast, the remainder being employed by nonsea-going *towkays* (boat-owners). This is corroborated by findings from other studies (e.g., Malaysia, Division of Fisheries 1971) and reflects the interregional differences in the ownership structure of fishing assets. Related to this feature, the East Coast has been the major target of the government's program of subsidies to fishermen to promote boat ownership (Yahaya 1976). One reason for the interregional ownership differences could be that, because the West Coast vessels were relatively small, a lower capital investment was required; conversely, the larger vessels on the East Coast required a larger investment that only a few fishermen could finance.

Labour and Employment

The majority of the trawl net and handline units on the East Coast had a crew of three or four, whereas on the West Coast, the average for all types of gear was one or two per crew. The reasons behind this regional difference include the size of the boat, capital-labour intensity of fishing gear, and wage rates.

The average number of days fished in a month varied considerably across gear types and locations; the majority fished 11-25 days/month with very few fishing less than 11 days or more than 25 days. As might be expected, the number of days at sea was generally influenced by the size of boat and engine horsepower in relation to the weather and coastal topography. There was also considerable variation in the average number of working hours per day across gear types. In general, most gear types were operated 6-15 hours, the exceptions being the trawl net and handline in Kuala Trengganu. The number of hours per fishing day was also related to the boat size and engine horsepower, which enable certain gears to stay at sea for longer periods.

Table 3. Distribution of total family labour supply by gear type and location, Peninsular Malaysia, 1979.

Location and gear type	Total supply	Nonfishing: School children	Nonfishing: House wives	Nonfishing: Other	Fishing: Potential	Fishing: Actual	Surplus labour	Average per household: Total	Average per household: Potential
Pantai Remis									
Shrimp trawl net	120	42	25	1	52	29	23	4.6	2.0
Drift net	35	9	7	5	14	13	1	5.0	2.0
Shellfish collection	40	4	11	0	25	15	10	3.6	2.3
Longlines	65	16	11	0	38	15	23	5.9	3.4
Port Weld									
Shrimp trawl net	245	57	37	4	147	85	62	6.3	3.8
Drift net	120	38	17	2	63	43	20	6.7	3.5
Shellfish collection	90	28	18	4	40	23	17	5.0	2.2
Kuala Trengganu									
Trawl net	181	46	44	2	89	60	29	3.7	1.8
Handlines	380	92	80	7	201	60	141	4.5	2.4

Few male household heads were involved in fishing-related occupations such as fish processing and marketing whereas women worked in the service sector and in private enterprise. However, the participation of women in economic activities was generally negligible.

To estimate labour surpluses among fishing households, we analyzed data on labour supply and employment (Table 3). The total fishing household or family labour supply, defined as all household members above 10 years,[2] indicates the total labour resources available for fishing and nonfishing activities. We refined this total by allowing for those family members involved in nonfishing activities such as household activities, attending school, etc. The potential fishing labour force was then matched against the labour actually engaged in fishing and nonfishing activities to obtain a crude estimate of surplus labour in the sample. This surplus was highest among handline operators in Kuala Trengganu on the East Coast and lowest among drift net operators in Pantai Remis on the West Coast. It is recognized that the labour utilization aproach suffers from several weaknesses including specification of a work norm and a standard unit of operation. Furthermore, the assumption that unemployed labour units would be available for fishing operations needs to be reexamined in view of the unwillingness of rural youth to engage in fishing and other rural-based activities. More appropriately, labour supply should be specified as a function of real wages within a work-leisure theoretical framework.

When the labour surplus estimates are compared with household incomes (see Table 4), there is an apparent inverse relationship between the size of the surplus and gross monthly household incomes. The handline operators in Kuala Trengganu with the highest labour surplus earned the lowest incomes, whereas the drift net operators in Pantai Remis earned the highest incomes and had the second lowest surplus. However, this relationship is not as clear for the other gear types in the sample.

Incomes and Income Distribution

We examined income levels of and income distribution patterns among the fishermen operating the various gears. The importance of fishing and nonfishing incomes and their distribution among gear types, within gear types, and between locations and ethnic groups operating the same gear type were also analyzed.

The concept of income we used is gross monthly household income received by heads and other household members from fishing and nonfishing sources (Table 4). The main components of fishing incomes are wages and payments in kind received by heads and household members and returns to boat owners. Of the total fishing income earned by households, 90% is generated by household heads, the balance is earned by other household members or comes from other boats. Wages and returns to boat owners account for 93% of total fishing incomes, the balance being payments in kind and bonuses.

For the whole sample, fishing incomes account for 95% of total household incomes (Table 4). Nonfishing incomes, earned by both male and female adults in the fishing household

[2]This definition is used in the 1970 Population and Housing Census of Malaysia.

Table 4. Average fishing and nonfishing monthly income per household (MYR)[a] of small-scale fishing labour households, Peninsular Malaysia, 1979.

Location and gear type	Fishing income				Nonfishing income	Total income	Fishing income as % of total
	From sample boat						
	Head of household	Other members of household	From other fishing boats	Total			
Pantai Remis							
Shrimp trawl net	562	7	14	583	34	617	94.49
Drift net	522	108	37	667	26	693	96.25
Shellfish collection	234	90	11	335	0	335	100.00
Longline	522	32	0	554	20	574	96.52
Port Weld							
Shrimp trawl net	350	48	0	398	11	409	97.31
Drift net	319	53	0	372	0	372	100.00
Shellfish collection	345	7	0	352	49	401	87.78
Kuala Trengganu							
Trawl net	157	5	12	174	12	186	93.55
Handline	92	18	4	114	9	123	92.68

[a]2.19 ringgits (MYR) = US$1.

are from fishing-related occupations. The importance of fishing incomes reflects the lack of alternative employment opportunities in the area. Among the three locations, fishing households in Pantai Remis on the West Coast earned the highest gross monthly incomes, 550 MYR/household, compared to 394 MYR earned by households in Port Weld, also on the West Coast, and only 155 MYR by households in Trengganu on the East Coast (2.19 ringgits [MYR] = US$1). The average income of the sample fishermen on the two coasts, 410 MYR/month, is considerably higher than the average income of fishermen in general, 200 MYR/month, or of paddy farmers, 154 MYR/month, but it is lower than the 450 MYR mean monthly household income of rubber smallholders. Mean monthly household income amounted to 483 MYR for the West Coast, where 25% of households were below the mean, and 155 MYR for the East Coast, where 90% were below the mean.

Income differentials among sample fishing households are measured by the Gini concentration ratio and Lorenz curves were used to show the degree of inequality or the relative variability of income (Fig. 2). However, because interpretation of Lorenz curves is difficult when they intersect, the Gini concentration ratios (Table 5) are more useful. The lowest degree of income inequality is shown by the drift net operators in Pantai Remis with the greatest disparity among the handline operators in Kuala Trengganu. It is interesting that these two groups had the highest and lowest monthly incomes per household respectively. This contrasts with the experience of Lim (1971:149) who found that states with higher mean income levels displayed greater inequality in income distribution.

Another approach to the examination of income inequalities is to summarize the decile distribution of income by gear type and location (Table 6). (Decile points are those points on the income scale that include 10% of the total income recipients.) Disparities are most severe for the handline operators in Kuala Trengganu

Table 5. Gini concentration ratios of gross monthly fishing-household incomes by location, gear, area, and ethnic group, Peninsular Malaysia, 1979.

Location, area, and ethnic group	Concentration ratios
Location	
Kuala Trengganu	
Trawl net	0.3194
Handlines	0.4464
Port Weld	
Shrimp trawl net	0.2234
Drift net	0.2370
Shellfish collection	0.2315
Pantai Remis	
Shrimp trawl net	0.3058
Drift net	0.0907
Shellfish collection	0.2274
Longlines	0.2600
Area	
West Coast	0.2753
East Coast	0.4101
Ethnic group	
Malays	0.2395
Chinese	0.2824

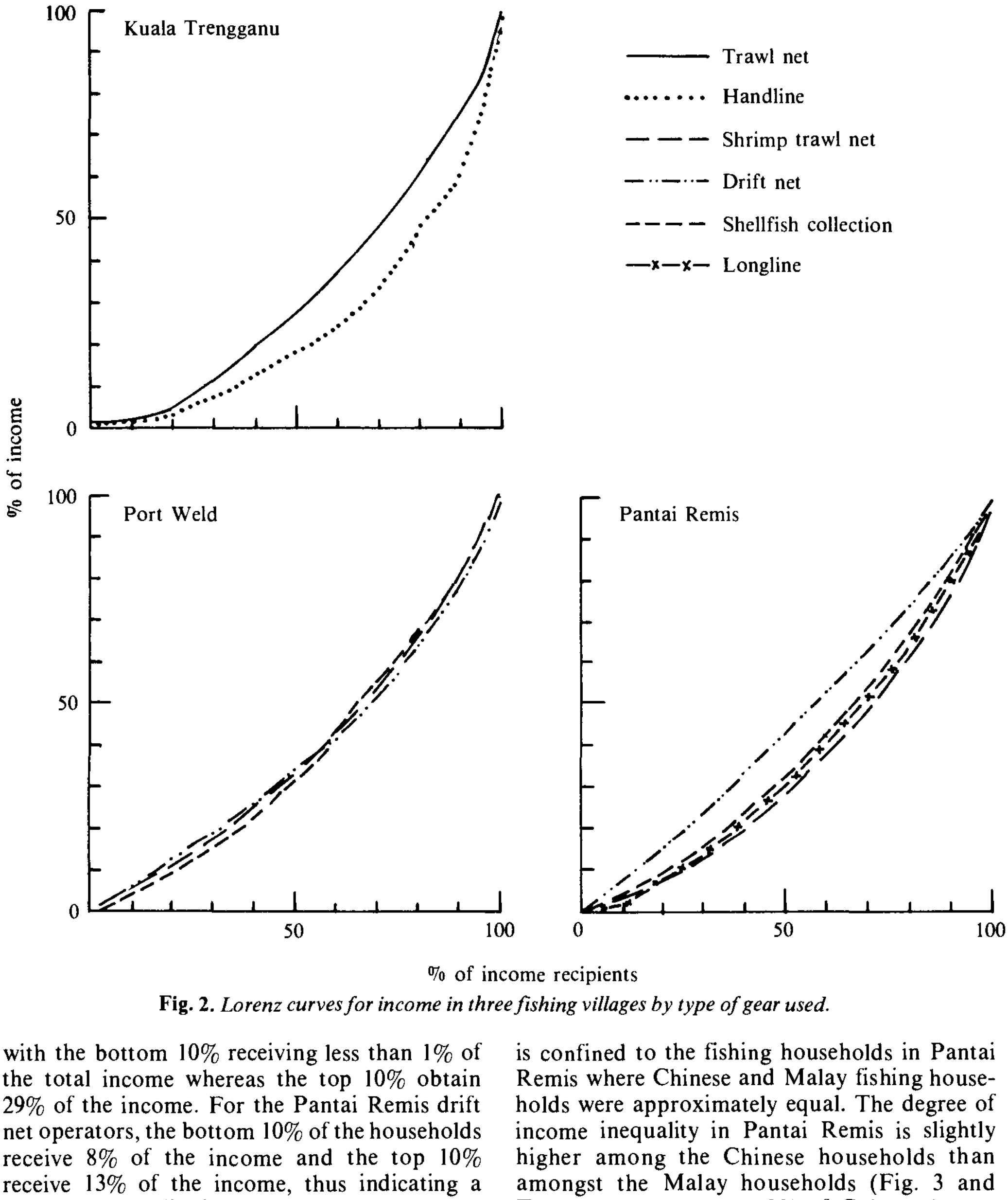

Fig. 2. *Lorenz curves for income in three fishing villages by type of gear used.*

with the bottom 10% receiving less than 1% of the total income whereas the top 10% obtain 29% of the income. For the Pantai Remis drift net operators, the bottom 10% of the households receive 8% of the income and the top 10% receive 13% of the income, thus indicating a more equitable distribution of income.

The degree of income inequality is higher on the East Coast than on the West Coast (Fig. 3 and Table 5). The bottom 10% of households in the East Coast receive barely 1% of the income whereas the top 10% receive 27%. On the West Coast, the income share of the bottom 10% was about 4% and that of the top 10% was 21% (Table 7).

In computing the degree of income inequality between the various ethnic groups, the analysis is confined to the fishing households in Pantai Remis where Chinese and Malay fishing households were approximately equal. The degree of income inequality in Pantai Remis is slightly higher among the Chinese households than amongst the Malay households (Fig. 3 and Table 5). The bottom 10% of Chinese households earn about 4% of the incomes whereas the lowest decile of Malay households earn less than 3% of the incomes. The top 10% of Chinese and Malay households earn 22% and 17% of the incomes respectively (Table 7).

Summary and Policy Implications

The sociodemographic profile of the sample fishing households reflects several characteris-

Table 6. Distribution (%) of gross monthly incomes by gear type and location, Peninsular Malaysia, 1979.

Distribution of families (deciles)	Port Weld			Pantai Remis				Kuala Trengganu	
	Shrimp trawl net	Drift net	Shellfish collection	Shrimp trawl net	Drift net	Shellfish collection	Long-lines	Trawl net	Handlines
Bottom	5.1	5.1	4.7	3.0	8.0	3.9	2.8	1.5	0.9
2nd	5.8	6.0	5.7	4.4	8.3	6.4	5.4	4.2	3.0
3rd	6.6	6.5	6.4	5.6	8.8	6.8	5.9	6.7	4.5
4th	7.7	7.7	7.8	7.5	9.4	7.6	7.6	7.6	5.1
5th	8.3	8.3	8.3	8.3	9.4	8.3	9.3	8.3	5.2
6th	10.3	8.8	10.8	9.5	9.9	10.2	10.8	9.7	6.5
7th	10.8	10.0	10.1	10.3	10.1	12.5	11.5	10.7	8.4
8th	12.1	12.7	12.3	12.9	10.6	13.0	13.2	11.7	16.0
9th	14.2	15.6	15.2	15.3	12.1	15.2	14.0	15.0	21.0
Top	18.5	19.1	17.8	23.0	12.9	16.4	19.2	24.5	28.8
Mean income (MYR)[a]	409.16	372.03	401.24	616.55	693.23	335.00	573.69	186.14	122.95

[a]2.19 ringgits (MYR) = US$1.

Table 7. Distribution (%) of gross monthly incomes by location and race, Peninsular Malaysia, 1979.

Distribution of families (deciles)	Area[a]		Race[b]	
	West Coast	East Coast	Malays	Chinese
Bottom	4.0	0.9	2.5	3.8
2nd	5.0	3.1	4.7	5.0
3rd	6.0	4.5	6.1	6.4
4th	7.1	4.9	8.2	7.6
5th	8.5	6.5	10.3	8.3
6th	9.5	9.6	11.4	9.3
7th	11.1	11.3	12.5	9.6
8th	12.7	14.4	13.7	12.1
9th	15.1	17.9	14.8	15.3
Top	21.0	26.7	17.0	22.4
Mean income (MYR)[c]	489.68	147.58	601.54	631.21

[a]Based on a sample of 263 households.
[b]Based on a sample of 53 households.
[c]2.19 ringgits (MYR) = US$1.

tics that are roughly comparable to the national fishing population. The concentration of household heads in the 30-51 year age group implies a low entry rate for rural youths into fishing and a high rate of out-migration from the fisheries sector. Fishing, which is a residual activity for coastal communities, is not viewed as a profitable economic activity by younger members of the rural community. Of the total family labour available for fishing, only 41% on the East Coast and 60% on the West Coast are actually engaged in fishing activities. This has important implications both for the future supply of experienced fishermen and for government investment in the fisheries sector. Policy measures to increase incomes and productivity from fishing and fishery-related activities should be formulated.

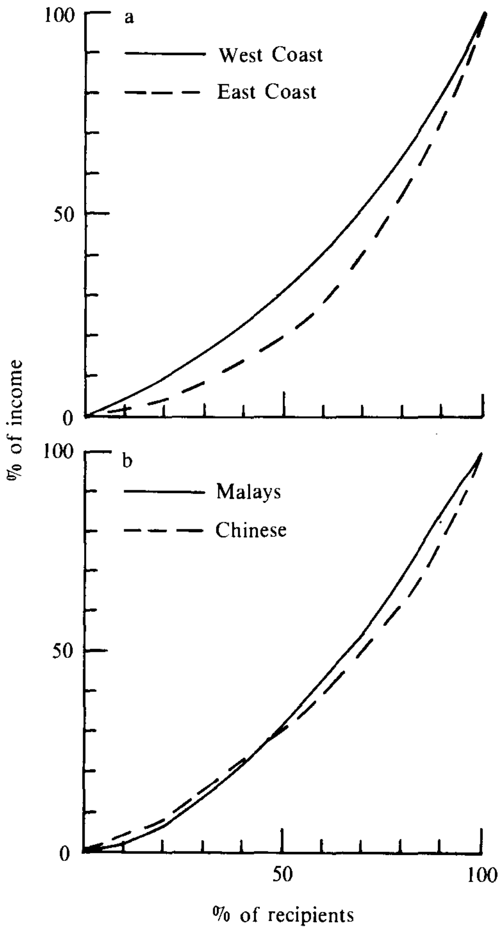

Fig. 3. *Lorenz curves for income (a) on the East and West Coasts of Peninsular Malaysia and (b) of Malay and Chinese families in Pantai Remis on the West Coast.*

The average family size of 6.3 persons/household is higher than the national average for all fishing households in Peninsular Malaysia. However, the number of fishermen per household is low, averaging 1.2 and 1.5 persons in the East Coast and West Coast respectively thus indicating a high dependancy ratio. The low level of family labour utilization in fishing households, even among owner-operated gears, reflects the relatively low labour-capital ratios of fishing as compared with farming, as well as the "unsuitability" of fishing as an occupation for female members of the household.

An examination of employment characteristics of fishing households indicates not only low levels of utilization of family labour in fishing and fish-related occupations but also in nonfishing occupations and thus the presence of surplus labour in the fisheries sector. The existence of this surplus is confirmed in our study and further substantiated by a survey of the Fisheries Division, which indicates that there is a surplus of 19 300 fishermen in the industry of whom 66.8% are located in the West Coast and the rest in the East Coast. This implies a high degree of dependence on fishing heads of households. The low incomes and output derived from fishing has led to the emergence of policy goals related to employment generation and more intensive labour utilization in the fisheries sector. To enhance incomes and living standards within the fisheries sector, measures to relocate some of the surplus population who currently depend on fishing to other activities, such as manufacturing and land development, should be investigated.

Income levels and income distribution patterns among fishermen operating different gear types were examined by analyzing the importance of fishing and nonfishing incomes in total household incomes. The distribution of incomes among gear types, within gear types, between locations, and between different ethnic groups were also analyzed.

The analysis of household incomes revealed the importance of fishing incomes as opposed to nonfishing incomes, which accounted for less than 5% of total incomes. The total household income structure reflected the lack of alternative employment opportunities, thus alternative employment must be provided within the sector or surplus labour moved out of the area. Such a policy measure might improve incomes and employment for those remaining in fishing and for those who leave the sector.

Gross monthly household incomes were more than three times higher on the West Coast than the East Coast. The gross incomes earned by sample fishermen (410 MYR/month per household in 1979) were higher than the average rural monthly household income (355 MYR), the national average for the fishing sector (200 MYR), or the average for rice farmers (154 MYR), but these were considerably below the incomes of rubber smallholders (450 MYR) or *felda* settlers (810 MYR).

Income differentials among sample fishing households were measured using Gini coefficients, Lorenz curves, and decile distributions. The lowest degree of income inequality was among the Pantai Remis drift net operators who earned the highest income: at the same time, the highest degree of income inequality was found among the East Coast handline operators earning the lowest incomes. The decile distribution of incomes also supported this finding, which contrasts with other studies that have established a positive correlation between high mean income levels and high degree of income inequality.

Regionally, the distribution of income was more unequal on the East Coast than the West Coast. On the basis of ethnic group, Chinese households had a marginally higher degree of income disparity than Malay households. Data on relative disparities in income distribution by race, gear, location, and region are significant in formulating policy guidelines that must be based upon a differentiated approach rather than on the presumption that the fishing population is a homogeneous group.

Socioeconomic Conditions of Coastal Fishermen in Thailand: A Cross-Sectional Profile

Theodore Panayotou, Kamphol Adulavidhaya, Supanee Artachinda, Somporn Isvilanonda, and Thanwa Jitsanguan

In the past, the socioeconomic problems faced by small-scale fishermen[1] in Thailand have been largely ignored. This was partly due to a presumption that, sooner or later, small-scale fishermen would be absorbed by the rapidly progressing large-scale fishing sector (either by acquiring advanced technology or by becoming labourers on large trawlers); otherwise, they would be forced to alternative, more profitable, occupations.[2] Leaving aside the social problems that such a transformation would have generated, the fact is that the small-scale fishermen, despite their apparently deteriorating standard of living, continue to exist alongside a highly profitable large-scale fishing sector. A number of explanations for this dualistic structure and persisting poverty have been advanced, ranging from the lack of advanced technology to the depletion of fish resources; from a suspected gambling behaviour among fishermen to the alleged exploitation by unscrupulous middlemen; and from the lack of alternative employment opportunities to fishermen's occupational and geographical immobility. Smith (1979) has reviewed these issues and proposed several hypotheses concerning the conditions of traditional fishermen in Southeast Asia.

However, not only has the testing of such hypotheses not been carried out, but also the required data that would make such a testing possible are not available despite the growing number of socioeconomic studies and surveys (for example, Thailand, Department of Fisheries 1978). In Thailand, more than in other Southeast Asian countries, the collection of fishery statistics has been confined to the large-scale fishing sector to the point that even the numbers of small-scale fishing communities, of fishing-dependent population, and of fishermen are not known with any accuracy. Officially, it is reported that about 250 000 people depend on fishing for a living. The number of fishermen is put around 65 000 of whom 30% are large-scale fishermen. Others, however, have inferred a total of 90 200 fishing households in the 1563 fishing villages of the 23 coastal provinces, bringing the fishing-dependent population up to 800 000 (see Panayotou 1980a for details).

Also, the standards of living and general socioeconomic conditions of coastal fishermen are thought to suffer from stagnation, if not gradual deterioration, despite the remarkable economic growth (in terms of income per person) attained in the rest of the economy — gross national product (GNP) per person has been growing at an average rate of almost 5% annually over the past two decades. Although the large-scale fishermen are doing considerably better than the national average, the small-scale fishermen are often among the ranks of the less-privileged income groups. The Thai government, in its attempts to reduce income disparities (NESDB 1977:5), has encountered a severe

[1]In referring to small-scale fishermen, a variety of terms is used, such as traditional, artisanal, subsistence, etc., which, although not synonymous (see Smith 1979), are often used interchangeably to convey the smallness of the operations relative to those of the industrial fisheries. In the present study, the term small-scale means both small and traditional in the sense of primitive gear. The term coastal fishing is used to convey a limited fishing range and, as such, it includes both traditional and modern gear (and vessels) that limit operations to the vicinity of the home base.

[2]An expression of this presumption has been the spending of 80% of a US$75 million budget over the period 1954-75 on projects benefiting the large-scale sector, for example, marketing and port structures, roads, and navigation facilities.

lack of comprehensive information on small-scale fisheries.

In response to the urgent need for and severe lack of reliable information on small-scale fishing communities, Kasetsart University with the collaboration of the Thai Department of Fisheries, Ministry of Agriculture and Cooperatives, undertook a study of the socioeconomic conditions of small-scale fishermen on the coast of Thailand with support from the International Development Research Centre of Canada (IDRC), which concurrently sponsored similar research projects in other Asian countries.

This paper is a preliminary attempt to draw a cross-sectional profile of the standard of living of coastal fishermen in Thailand, using information collected through interviews conducted in April 1979 at four sites in Southern Thailand. (Note that all values are on the basis of fishermen's recollection and refer to 1978.)

Sites and Samples

Four coastal provinces (*changwat*) — Chumporn, Nakhon Si Thammarat (referred to as Nakhon for brevity), Trat, and Pang Nga — were selected as a cross section of the coastal fisheries in Thailand. The term coastal fisheries is used throughout this chapter in a broad sense to include all the nonindustrial fishing units, i.e., owner-operated vessels (including those managed, but not operated, by retired fishing operators or nonsea-going housewives) whose fishing range is strictly limited to fishing grounds in the vicinity of the home port. This limitation is primarily due to the size (length, tonnage, and horsepower) of the vessel in relation to the morphology of the fishing grounds. The purposely loose definition permits the inclusion of the entire range of fishing units stretching from stationary gear without boat, through small, nonmotorized boats and outboard-powered vessels, to small trawlers, while excluding the resilient and highly developed industrial fisheries, whose activities include distant-water fishing (for a detailed study of the Thai industrial fisheries, especially trawl fishing, see Panayotou 1980b).

Geographically, the four project sites were selected so that one site, Trat was on the east coast of the Gulf of Thailand, two, Chumporn and Nakhon, were on the west, and one, Pang-Nga, was on the Andaman Sea (Fig. 1). Religion was also a factor in selecting the four provinces: Chumporn and Trat are purely Buddhist communities, Pang Nga is predominantly Muslim, and Nakhon mixed. A third criterion in the selection of sites was the level of fisheries development: Nakhon and Pang Nga are small-scale fisheries whereas Chumporn and Trat are small- to medium-scale by comparison with Thailand's industrial fisheries.

The selection of provinces was followed by the selection of districts (*amphoe*) within each province. In the first step, the coastal district with the largest fishing population was chosen on the basis of information provided by the Department of Fisheries. In all four provinces, this led to the selection of the central district (*amphoe muang*) within which the provincial capital is located. On the basis of information provided by provincial fishery officials, clusters of villages (*tambol*) in which more than 50% of the households are engaged in fishing were identified. (A household is said to be engaged in fishing, or to be a fishing household, if it derives at least 50% of its income from fishing operations or fishing employment.) From each selected *tambol*, only villages with predominantly fishing populations (over 80% of the households) were included. Once the villages were selected, a random sample of about 30% of the fishing households from each village was drawn.

However, the particular circumstances of each project site made it necessary to modify the general procedure. In the case of Trat, one predominantly fishing district, Klong Yai, was excluded for security reasons arising from the Kampuchean conflict — the selection of project sites had taken place before the Kampuchean conflict — and as a result, only 137 households out of a target of 250 were sampled. In Chumporn, however, the sample was supplemented from the neighbouring subdistrict of Tha Tako, which forms a natural extension of the central district and was, in earlier times, part of the central district. The inadequacy of the sample from the central district in Chumporn arose from the deliberate exclusion of the large-scale fisheries based in this district. Finally, in Nakhon, the inclusion of two entire districts was necessary to obtain a representative sample of the fishermen in the province: the central district, located in a gulf, is predominantly Muslim whereas Pak Panang, located on a peninsula, is Buddhist. The larger sample for Nakhon, 290 households, is also warranted because its fishing population is far larger than the other three provinces. According to the rather outdated fisheries census (Thailand, Department of Fisheries 1967), Nakhon has more than twice as many fishing households as Chumporn or Pang Nga. The samples in Chum-

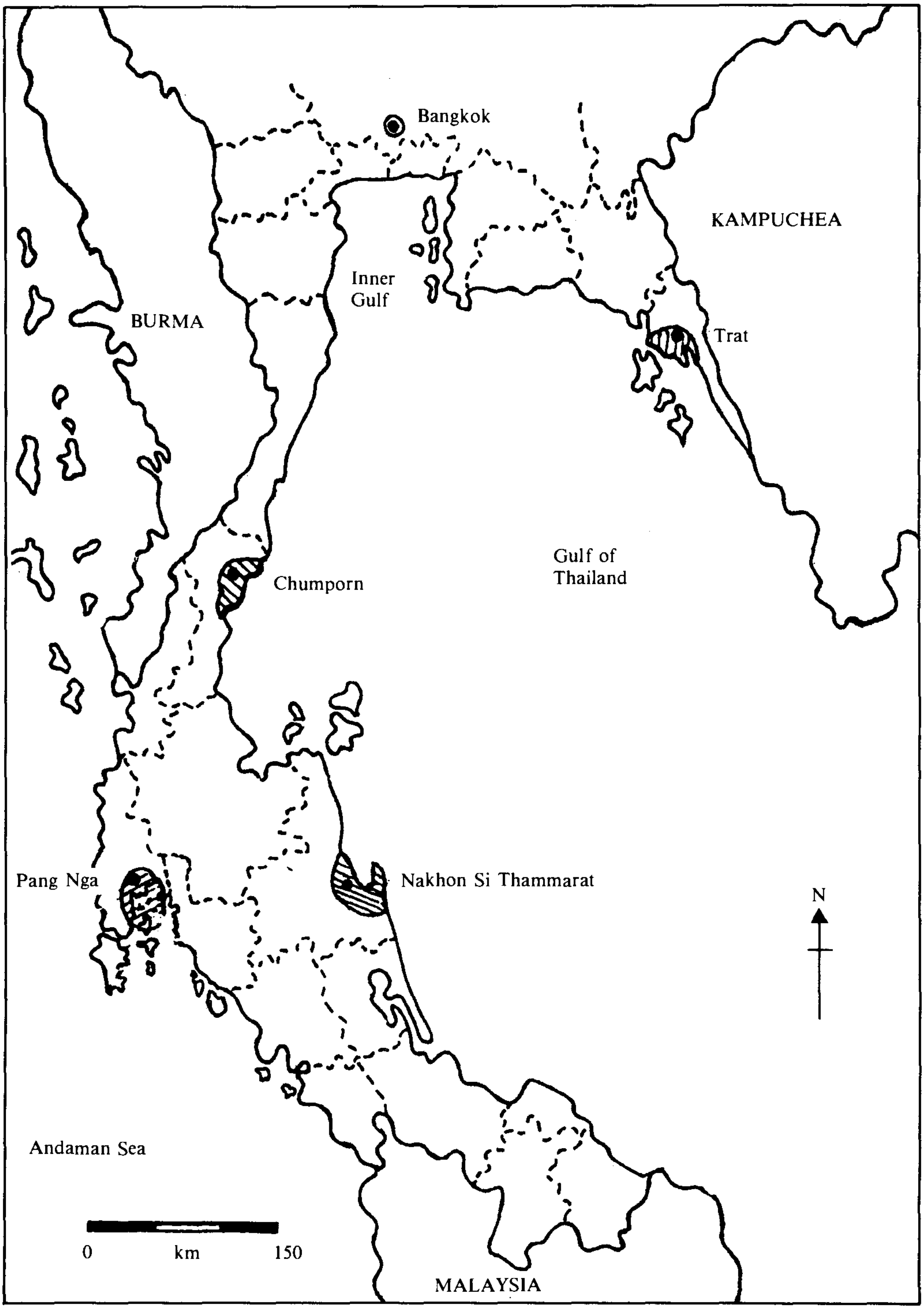

Fig. 1. *Southern Thailand showing project sites (shaded).*

porn and Pang Nga were 217 and 247 households respectively, bringing the total sample for all four provinces to 891 households.

This rather complex sampling procedure resulted from the lack of comprehensive and reliable information on the population and the location of small-scale fishing households, as well as from an attempt to obtain a fairly representative sample at minimal cost. However, the nonrandomness of the selection of provinces and districts limits the inferences that can be made about the population from which the sample has been drawn. Moreover, the choice of central districts by virtue of their size and central location biases the sample against scattered and isolated fishing communities, which are often the poorest of the poor. Had the number of fishing households in each province been known with any accuracy and had costs in terms of funds, time, and risk (piracy, insurgency, or international conflict) not been prohibitive, a proportional sample (say 10%) of the fishing households from each province would have been preferable.

Sociodemographic Profile

Although the unit of analysis was the fishing household, here we focus on the sociodemographic profile of the household head alone (Table 1) because this is closely related to the socioeconomic conditions of the household as a whole. A combination of partriarchy and the nature of fishing occupation accounts for the predominance of males as heads of fishing households: less than 3% of the sampled households are headed by females and more than 50% of these are widows of fishermen. As expected, differences among the four locations were slight, except that the purely Buddhist (high-income) communities of Trat and Chumporn appear to have a somewhat higher percentage of females as heads of households than those with considerable (low-income) Muslim populations. The differences, however, are so small that they may be due to sampling errors.

Not surprisingly, the largest age group, both in the total and the individual samples, is the middle one (36–50 years) accounting for about 40% of the household heads. However, there are significant differences in age structure among locations: 35% of the household heads in Pang Nga and 32% in Chumporn are over 50 years of age whereas the corresponding values for Trat and Nakhon are only 25% and 19% respectively. These differences may be attributed to differences among locations in the profitability of fishing relative to the availability and profitability of alternative employment opportunities. In Pang Nga, where fishing is relatively unprofitable (see Table 6) and nonfishing opportunities,

Table 1. Sociodemographic profile of heads of small-scale fishing households, Thailand.

	Chumporn		Nakhon		Trat		Pang Nga		Total	
	Number	%	Number	%	Number	%	Number	%	Number	%
Total sample	**217**	**100.0**	**290**	**100.0**	**137**	**100.0**	**247**	**100.0**	**891**	**100.0**
Sex										
Male	211	97.2	283	97.6	132	96.4	241	97.6	867	97.3
Female	6	2.8	7	2.4	5	3.6	6	2.4	24	2.7
Age (years)										
<20	1	0.5	0	–	1	0.7	0	–	2	0.2
20–35	60	27.6	99	34.1	39	28.5	67	27.1	265	29.7
36–50	87	40.1	136	46.9	63	46.0	94	38.1	380	42.7
>50	69	31.8	55	19.0	34	24.8	86	34.8	244	27.4
Marital status										
Married	207	95.4	281	96.9	131	95.6	245	99.2	864	97.0
Single	5	2.3	2	0.7	6	4.4	1	0.4	14	1.5
Widow(er)	5	2.3	7	2.4	0	–	1	0.4	13	1.5
Religion										
Buddhist	217	100.0	196	67.6	137	100.0	0	–	550	61.7
Muslim	0	–	94	32.4	0	–	247	100.0	341	38.3
Formal education										
None	12	5.5	41	14.1	20	14.6	86	34.8	159	17.8
Grade 1–4	186	85.7	237	81.7	112	81.8	159	64.4	694	77.9
Grade 5–7	7	3.2	8	2.8	4	2.9	2	0.8	21	2.4
Beyond grade 7	12	5.6	4	1.4	1	0.7	0	–	17	1.9

Table 2. Sociodemographic profile of family size and working members of small-scale fishing households, Thailand.

	Chumporn	Nakhon	Trat	Pang Nga	Total
Family size[a] (% of households)					
1–2	6.5	3.8	5.1	1.6	4.1
3–5	35.9	31.4	44.5	30.8	34.3
6–8	37.3	37.8	37.2	38.5	39.7
9 and more	20.3	21.0	13.2	29.1	21.9
Average family size (number)[a]	6.5	6.6	5.8	7.0	6.6
Average working members per family (number)	2.6	2.0	2.6	2.9	2.5
Working members as % of average family size	40.0	30.3	44.8	41.4	37.9
Working family members other than head					
Male (% of total)	39.5	56.6	36.0	60.9	49.9
Female (% of total)	60.5	44.4	64.0	39.1	50.1
Total (number)	342	292	225	462	1321

[a]Includes the head of the household.

especially small-scale mining,[3] are abundant, fishing is becoming more of a "grandfather" occupation as younger fishermen shift to more profitable activities. Only 65% of the fishermen in this province are below 50 years of age compared to 68% in Chumporn, 75% in Trat, and 81% in Nakhon — in rough terms only because not all heads of fishing households are fishermen nor are all fishermen household heads. Chumporn has a moderately profitable fishery and numerous alternatives for employment, Trat has a very profitable fishery but little else, and Nakhon lacks both.

Over 95% of all household heads in all project sites are married, the percentage being highest in the purely Muslim district of Pang Nga. The number of "singles" is somewhat higher in the all-Buddhist, high-income communities of Trat and Chumporn whereas Nakhon, where two-thirds of the population are Buddhist and one-third Muslim, is an intermediate case.

Somewhat surprisingly, the level of formal education attained (literacy) is not related to income or religion. Although literacy is highest in Chumporn and lowest in Pang Nga, Nakhon with an average household income considerably less than half that of Trat (see Table 6) has the same (if not a higher) level of literacy although less than neighboring Chumporn (Table 1). Although more than 80% of fishermen in all provinces, except Pang Nga, have attended at least some of the compulsory first four grades, few have gone beyond grade four. (In recent years, but not simultaneously in all locations, compulsory education up to grade seven has been introduced.) The lower levels of literacy in Pang Nga may have more to do with the geography of the province — small and dispersed communities on remote islands — than with religion.

[3]It is well known that over 5000 fishing-turned-suction boats are mining tin off the Pang Nga coast (for further details, see Panayotou 1979).

The family size is clearly influenced by income levels and religion (Table 2). In Buddhist, high-income Trat, 50% of the interviewed fishing households had less than six members including the head of the household. In Chumporn, with a somewhat lower income, but similarly Buddhist, 42% of the households had less than six members. In contrast, 68% of the households in Muslim Pang Nga had more than five members and almost 30% had at least nine members. Correspondingly, the average family size ranged between 5.8 members in Trat and 7.0 in Pang Nga. Households in Trat had the largest percentage of working members (46) and Nakhon the lowest (31).

The observed considerable differences in the proportion of women among working family members other than household head (Table 2) may be attributed to two factors, religion and availability of employment opportunities suitable for women. In Muslim Pang Nga, less than 40% of the working household-members are women, compared with more than 60% in the Buddhist provinces. Among the latter, the percentage of women is highest in Trat because of the greater opportunities for fish processing at home (see Table 3). In Nakhon, which is partly Muslim and lacks nonfishing opportunities in general, women make up only 44% of the working household members. Considering that Nakhon is only one-third Muslim, the percentage of women among working family members is too low to be justified by religion alone: the lack of suitable employment opportunities for women must also be a determining factor.

Occupational Structure

Unlike large-scale fishermen, whose main and usually only occupation is as an owner-operator of a fishing unit (FO),[4] coastal fishermen and their families undertake a variety of supplementary occupations concurrently or during the nonfishing season. Some of these occupations, such as hired fishing labour (FL) and fish processing (FP), are closely related to fishing, whereas others, such as farming, mining, and unskilled labour employment are unrelated, and are referred to here as nonfishing (NF) activities.

Nonfishing occupations serve a number of purposes in a small-scale fishing household:

- They supplement low and fluctuating fishing incomes;
- They provide employment for family labour, especially those less apt to take up fishing, such as female family members;
- They help diversify the fisherman's income away from the highly uncertain and seasonal fishing operations; and
- They provide employment for the fisherman during the nonfishing season.

The percentage of fishermen and of other household members engaged in any one or a combination of these activities is related to their need for such supplements as well as the profitability of the latter vis-à-vis fishing. In analyzing the frequency distribution of household heads and members among fishing-related and nonfishing activities (Table 3), Tables 6 and 8 give a general picture of the relative profitability of the two groups of activities in different locations.

The highest percentage of "pure" fishing operators among household heads was found in Chumporn (63%) where the profitability of fishing operations is the highest by comparison both to fishing in other provinces and to other occupations in the same province. It was lowest (54%) in Pang Nga where a combination of a relatively unprofitable fishery and abundant well paying alternatives (e.g., mining) induces about 30% of fishing operators to take up nonfishing occupations as well. Nakhon and Trat fall somewhere between these two extremes, but for different reasons: in the former, fishing is not very lucrative but there is little else to do and, in the latter, fishing at sea is profitable but so is fish processing at home. When fishing operation and fish processing are combined (Table 3, FO only plus FO + FP), Trat has the highest percentage of independent fishermen (74) and Nakhon the lowest (60). By "independent fishermen," we mean persons engaged in fishing-related activities as independent economic units, not as hired labourers in fishing or processing.

The most common combination of employments is fishing operations with nonfishing activities (FO + NF) rather than with fishing labour (FO + FL). Pang Nga has the highest percentage of household heads engaged in such a combination, followed by Nakhon: the former because of the availability and profitability of nonfishing employment and the latter because of necessity. Fishing labourers, with few exceptions, work only as crew, leaving secondary occupations to their families. Fishing labourers are of some importance in Chumporn and Nakhon (about 10%) but are conspicuously absent in Pang Nga. A last group, that of retired fishermen (RF) who still manage fishing operations from the home base, is sizable only in the more developed fisheries of Trat and Chumporn.

Similar comments can be made about the occupational structure of household members other than the head (Table 3). As expected, fishing operations are the dominant occupation among male members in all locations, but fishing labour is also important in Nakhon. Fish processing, and in its absence appropriate nonfishing activities, is the dominant occupation among female members: in Pang Nga and to a lesser extent in Trat both these opportunities exist.

For a nonfishing occupation to be "appropriate," it must fit the particular circumstances of the fishing household:

- It should be available during the nonfishing season without requiring continuation of the engagement of the fisherman himself during the fishing season;
- It must be physically located in the vicinity of the household's fishing activities;
- It must fit the demographic structure (sex and age) and skills of family labour; and
- It must not require investment outlays beyond the means of the small-scale fishing household.

When nonfishing occupations are further subdivided into farming, resource extraction, small business, and wage employment (Table 4), farming was the most common nonfishing activity for household heads in all locations.

[4]In the present study, only sea-going owner-operators of fishing units have been considered. The combination in the same person of the functions of ownership, management on land, and operation at sea is one of two main features on nonindustrial fisheries; the other is limited fishing range, as described earlier.

Table 3. *Distribution of household heads and members of small-scale fishing households by occupation, Thailand.*

	Chumporn		Nakhon		Trat		Pang Nga		Total	
Occupation[a]	No.	%	No.	%	No.	%	No.	%	No.	%
Household heads	**217**	**100.0**	**290**	**100.0**	**137**	**100.0**	**247**	**100.0**	**891**	**100.0**
FO only	136	62.7	170	58.6	78	56.9	132	53.5	519	58.3
FO + FL	0	–	3	1.0	2	1.5	0	–	5	0.6
FO + FP	0	–	4	1.4	23	16.8	20	8.1	47	5.3
FO + NF	26	12.0	56	19.3	7	5.1	64	25.9	150	16.8
FO + FL + FP	0	–	0	–	1	0.7	0	–	1	0.1
FO + FL + NF	0	–	1	0.4	1	0.7	0	–	2	0.2
FO + FP + NF	0	–	0	–	2	1.5	17	6.9	19	2.1
FL only	26	12.0	32	11.0	6	4.4	0	–	64	7.2
FL + NF	1	0.4	5	1.7	0	–	0	–	6	0.7
NF only	8	3.7	7	2.4	4	2.9	7	2.8	26	2.9
RF only	20	9.2	12	4.2	13	9.5	7	2.8	52	5.8
Other household members[b]	**342**	**100.0**	**292**	**100.0**	**225**	**100.0**	**462**	**100.0**	**1321**	**100.0**
FO	129	37.7	140	48.0	82	36.4	182	39.4	533	40.4
FL	33	9.7	48	16.4	5	2.2	16	3.5	102	7.7
FP	20	5.8	23	7.9	90	40.0	104	22.5	237	17.9
NF	160	46.8	81	27.7	42	18.7	159	34.4	442	33.5
FP + NF[c]	0	–	0	–	6	2.7	1	0.2	7	0.5

[a]FO = Fishing operators; FL = Fishing labour; FP = Fish processing; NF = Nonfishing operators; FR = Retired fishing operators or housewives, nonsea-going but still managing fishing operations.
[b]Only main occupation was reported for other household members.
[c]Both FP and NF were reported as main occupations as the household member devoted equal amounts of time to the two occupations.

About 70% of all nonfishing jobs in the more developed provinces of Trat and Chumporn were in farming, especially in coconut and rubber plantations. In Pang Nga, just over 50% of the nonfishing jobs were in farming and, of these, 63% were in plantations. In the impoverished fishing communities of Nakhon, a wider variety of nonfishing jobs were undertaken. However, unskilled labour and mangrove cutting made up 43% of all nonfishing jobs undertaken by heads of households. In all other locations, wage employment, particularly unskilled labour, was the second most common nonfishing activity.

Clearly, activities such as rubber and coconut plantations, subsistence rice farming, and unskilled labour employment fit the fisherman's circumstances better than such activities as cash-crop farming, livestock raising, fish farming, retail trade, or government office. This is not to say that if such occupations were available (and profitable) fishermen would not have given up fishing but only that they constitute alternatives rather than supplements to fishing.

The situation with the rest of the family is somewhat different. Nonfishing activities should be complementary to those of the household head while fitting the particular demographic characteristics (sex and age) of the family's labour. For example, retail trade (including fish marketing) is important in all sites because it satisfies both these conditions. As expected, it is more common in the more isolated communities of Nakhon and Pang Nga (Table 5). In these communities, retail trade contributes over 20% of all nonfishing jobs for household members, coming second only to unskilled labour employment, which accounts for about 45%. In the richer provinces of Chumporn and Trat, plantation farming is the dominant nonfishing activity for household members, followed by rice farming in Chumporn and wage employment in Trat. The different composition of unskilled labour employment is worth noting: farming and fish processing dominate in all sites except Pang Nga where mining accounts for about 50% of all unskilled labour jobs.

Fishing Income, Assets, and Employment

Corresponding to the occupational structure just described, a fishing household's income may be broken down into fishing and nonfishing

Table 4. Distribution of nonfishing jobs[a] by type of activity for household heads, Thailand.

Occupation	Chumporn No.	Chumporn %	Nakhon No.	Nakhon %	Trat No.	Trat %	Pang Nga No.	Pang Nga %	Total No.	Total %
Farming	**28**	**66.7**	**30**	**43.5**	**12**	**70.6**	**59**	**56.2**	**129**	**55.4**
Crop farming (e.g., rice)	6	14.3	18	26.1	2	11.8	11	10.5	37	15.9
Fruit orchard	1	2.4	0	–	2	11.8	11	10.5	14	6.0
Plantation[b]	21	50.0	4	5.8	8	47.0	37	35.2	70	30.0
Livestock	0	–	3	4.4	0	–	0	–	3	1.3
Fish farming	0	–	5	7.2	0	–	0	–	5	2.2
Resource extraction	**1**	**2.4**	**13**	**18.8**	**0**	–	**8**	**7.6**	**22**	**9.5**
Small-scale mining	0	–	2	2.9	0	–	4	3.8	6	2.6
Mangrove cutting	1	2.4	11	15.9	0	–	4	3.8	16	6.9
Small business	**2**	**4.8**	**4**	**5.8**	**0**	–	**13**	**12.4**	**19**	**8.2**
Boat operation/rental[c]	2	4.8	1	1.5	0	–	7	6.7	10	4.3
Retail trade[d]	0	–	3	4.3	0	–	6	5.7	9	3.9
Wage employment	**11**	**26.2**	**22**	**31.9**	**5**	**29.4**	**23**	**21.9**	**61**	**26.2**
Government office	1	2.4	1	1.5	0	–	1	1.0	3	1.3
Construction (e.g., carpentry)	4	9.5	2	2.9	0	–	0	–	6	2.6
Unskilled labour	6	14.3	19[e]	27.5	5	29.4	22[f]	20.9	52	22.3
Other	**0**	–	**0**	–	**0**	–	**2**	**1.9**	**2**	**0.9**
Total[a]	**42**	–	**69**	–	**17**	–	**105**	–	**233**	–

[a]Few of these jobs are full-time or permanent; most are part-time, seasonal, or temporary.
[b]Mainly coconut and rubber.
[c]Mainly for tourists (Pang Nga).
[d]Includes fish trading.
[e]74% in farming.
[f]27% in mining and 27% in boat driving.
[g]The total is larger than the sum of the rows involving nonfishing (NF) in Table 3 because some persons have more than one nonfishing occupation.

Table 5. Distribution of nonfishing jobs[a] by type of activity for household members, Thailand.

Occupation	Chumporn No.	Chumporn %	Nakhon No.	Nakhon %	Trat No.	Trat %	Pang Nga No.	Pang Nga %	Total No.	Total %
Farming	**126**	**71.2**	**23**	**29.9**	**29**	**50.0**	**17**	**10.4**	**195**	**41.2**
Crop farming (e.g., rice)	35	19.8	15	19.5	4	6.9	6	3.7	60	12.6
Fruit orchard	12	6.8	0	–	7	12.1	3	1.8	22	4.6
Plantation	71	40.1	2	2.6	18	31.0	3	1.8	94	19.8
Livestock	8	4.5	5	6.5	0	–	1	0.6	14	2.9
Fish farming	0	–	1	1.3	0	–	4	2.5	5	1.1
Resource extraction	**2**	**1.2**	**2**	**2.6**	**0**	–	**17**	**10.4**	**21**	**4.4**
Small-scale mining	1	0.6	0	–	0	–	14	8.6	15	3.1
Mangrove cutting	1	0.6	2	2.6	0	–	3	1.8	6	1.3
Small business	**15**	**8.5**	**17**	**22.1**	**11**	**19.0**	**43**	**26.4**	**86**	**18.1**
Boat operation/rental	1	0.6	0	–	0	–	9	5.5	10	2.1
Retail trade	14	7.9	17	22.1	11	19.0	34	20.9	76	16.0
Wage employment	**32**	**18.1**	**34**	**44.2**	**17**	**29.3**	**75**	**46.0**	**158**	**33.2**
Government office	1	0.6	0	–	0	–	2	1.2	3	0.6
Construction (e.g., carpentry)	3	1.7	0	–	0	–	0	–	3	0.6
Unskilled labour	28[b]	15.8	34[c]	44.2	17	29.3	73[d]	44.8	152	32.0
Other[e]	**2**	**1.2**	**1**	**1.3**	**1**	**1.7**	**11**	**6.7**	**15**	**3.2**
Total[f]	**177**	–	**77**	–	**58**	–	**163**	–	**475**	–

[a]Few of these jobs are full-time or permanent; most are part-time, seasonal, or temporary.
[b]54% is in fish processing.
[c]65% is in farming and 21% in fish processing.
[d]Mining alone accounts for 48%.
[e]Includes dress makers.
[f]The total is larger than the sum of the rows involving nonfishing (NF) in Table 3 because some persons have more than one nonfishing occupation.

income and into income earned by the head of the household and by the rest of the family (see Table 6). This already complicated income structure, however, does not exhaust all sources of income. A small-scale fishing household, like a small-scale farming family, may receive part of its income in noncash form through consumption of own produce (e.g., fish, home-grown rice and vegetables, etc.), through barter exchange, or noncash payment for hired labour. Moreover, income from social sharing may contribute a nonnegligible portion of a household's income in some of the more traditional communities. By "social sharing," we mean material assistance provided by the more well-to-do members of the community to the disadvantaged members: it is more of a social organization trait than a charity.

This variety of sources and types of income for a fishing household may best be represented by the following 3 × 3 matrix:

$$\begin{bmatrix} Y_{11} & Y_{12} & Y_{13} \\ Y_{21} & Y_{22} & Y_{23} \\ Y_{31} & Y_{32} & Y_{33} \end{bmatrix}$$

Where Y_{ij} for j = 1 and i = 1,2 is cash income received by the head of the household from fishing and nonfishing activities respectively; Y_{ij} for j = 2 and i = 1,2 are the corresponding incomes received by other members of the household; Y_{ij} for i = 3 and j = 1,2,3 represents income from social sharing. Because the last row and column are often hard to quantify and, although noncash income and income from social sharing may comprise a significant part of a small-scale fishing household's income (and data have been collected for a rough quantification), the present study concentrates only on the cash income from fishing and nonfishing activities of the head and other members of the households (i.e., the principal elements in the matrix).

The dependence on fishing as a source of income varies considerably, ranging from 95% for Trat to 55% for Pang Nga (Table 6). Fishing-related activities include own fishing, fishing employment, and fish processing. Although own fishing accounts for over 80% of fishing income in all locations, fishing employment is of importance only in Chumporn and Nakhon and fish processing only in Trat and Pang Nga. The reasons behind these differences are the industrial fisheries in the Chumporn and Nakhon areas, which provide fishing employment opportunities, and the composition of catch in Trat and Pang Nga, which is suitable for small-scale processing. Blue crab and shellfish, the most prevalent species in the catch of Trat, are peeled and sold to a seafood-processing plant located in Trat. Mysis, the major species in the Pang Nga catch, is processed into shrimp paste at home. Blue crab is also one of the main species in Pang Nga. These two species are either absent or of minor importance in Chumporn and Nakhon.

The average household income from own fishing is highest in Trat, 5260 THB/month, and lowest in Nakhon, 1570 THB/month (20 baht [THB] = US$1). A number of hypotheses may be advanced to explain the striking differences in income, especially between the northern locations, Trat and Chumporn, and the southern, Nakhon and Pang Nga. As mentioned earlier, the fisheries of Trat and Chumporn are more developed with a longer fishing range than those of Pang Nga and Nakhon, which use mostly traditional gear such as bag nets, bamboo traps, lift nets, and cast nets, with a confining fishing range. These differences in the extent and possibly the richness of the fishing grounds and in the catching power of the fishing units should account, at least in part, for these income differentials. Additional hypotheses include differences in:

- Time spent fishing;
- Transport costs; and
- Degree of competition in input and output markets.

Although the formal testing of these hypotheses is beyond our scope and forms the subject of another study, we may still utilize whatever information we have at this stage regarding fishing time, value of fishing assets, location of sites, and composition of catch to examine the plausibility of these hypotheses.

The average household spent 26 man-days (defined as 8-hour working days) conducting fishing operations in Trat and 22 man-days in Chumporn, the northern provinces, compared with 18 in Nakhon and 17 in Pang Nga, the southern provinces (Table 7). A similar positive relation exists between income levels and current value of fishing assets (hull, engine, and gear), which represents catching power somewhat loosely. The average value of these assets per household was 27 256 THB in Trat and 25 996 in Chumporn compared with 10 631 THB in Nakhon and 6290 in Pang Nga (see Table 8).

More capital and a higher rate of utilization in the northern provinces in general, and in Trat in

Table 6. Average monthly net income[a] (THB)[b] of household by source, Thailand.

	Fishing income				Nonfishing income				
	Total	Own fishing	Fishing labour	Fish processing	Total	Farming	Hired labour[c]	Other[d]	Total income
Chumporn									
Household head	3999.27	3728.67	270.60	0.00	123.26	71.19	35.48	16.59	4122.53
Other members	680.75	371.94	232.16	76.65	839.91	317.17	137.10	385.64	1520.66
Household	4680.02	4100.61	502.76	76.65	963.17	388.36	172.58	402.23	5643.19
% of total	82.9	72.7	8.9	1.3	17.1	6.9	3.1	7.1	100.0
Nakhon									
Household head	1691.24	1496.32	192.42	2.50	329.10	150.03	118.93	60.14	2020.33
Other members	263.53	75.10	161.43	27.00	148.01	55.84	59.62	32.55	411.54
Household	1954.77	1571.42	353.85	29.50	477.11	205.87	178.55	92.69	2431.81
% of total	80.4	64.6	14.6	1.2	19.6	8.5	7.3	3.8	100.0
Trat									
Household head	4098.06	3561.03	198.54	338.49	78.05	40.43	37.63	0.00	4176.11
Other members	2215.21	1698.92	28.74	487.55	248.20	98.93	51.09	98.18	2463.41
Household	6313.27	5259.95	227.28	826.04	326.25	139.36	88.72	98.18	6639.52
% of total	95.1	79.2	3.4	12.5	4.9	2.1	1.3	1.5	100.0
Pang Nga									
Household head	1672.11	1541.07	0.00	131.04	566.14	96.65	228.14	241.35[e]	2238.25
Other members	571.60	305.39	36.72	229.49	1301.58	21.42	842.35	437.81[e]	1873.17
Household	2243.71	1846.46	36.72	360.53	1867.72	118.07	1070.49	679.16	4111.42
% of total	54.6	44.9	0.9	8.8	45.4	2.9	26.0	16.5	100.0

[a]The net cash income was obtained directly by questioning the fishermen and hence might be biased downward if the respondent regarded the interviewer as a "tax official" or upward if the respondant failed to subtract certain costs. Thus, the values should be regarded with caution and only as preliminary results, indicating a rough order of magnitude to enable cross-sectional comparisons among districts (it may be assumed that reporting errors are random). A more rigorous calculation of net cash income should await the computation of costs and revenues from fishing and nonfishing activities and the imputation of rental prices of fixed fishing and nonfishing assets.
[b]20 baht (THB) = US$1.
[c]Hired labour includes employment in mangrove cutting, charcoal production, fish processing, and carpentry as well as unskilled employment.
[d]Other includes public service, food shops, boat management, tailoring, car driving, duck and cattle raising, shrimp farming, barbering, handicraft production, and fish trading.
[e]The higher values in Pang Nga are due to the high profitability of mining.

particular, may explain their higher fishing incomes, especially when one considers that larger boats and more powerful engines mean more extensive fishing grounds. The apparent negative relationship between incomes and inputs of time and capital in the two southern provinces, Nakhon and Pang Nga, may be explained by differences in the state of the resource. In Pang Nga, the availability of profitable nonfishing alternatives such as mining and tourism has kept entry into the fishery at moderate levels. The relatively high opportunity cost of fishing has checked biological overfishing although economic overfishing is inevitable in an open-access fishery.[5] In contrast, Nakhon lacks comparable alternatives and the consequently lower opportunity cost of fishing, as compared to Pang Nga, implies a more heavily exploited fishery and thus the need for more effort for the same amount of catch.

However, differences in the quantities of inputs (fishing effort) and outputs (catch) are not the only factors that may result in varying profitability of fishing operations among sites. Differences in fish prices received and input

[5]Biological overfishing is defined as the reduction of a fish stock through fishing below the level that gives maximum growth and hence maximum sustainable yield. Although no stock assessment has been carried out specifically for Pang Nga Bay, there is biological evidence that the Andaman Sea is, in general, less heavily exploited than the Gulf of Thailand, but this may be due more to the geomorphology and history of the area than to economics. Economic overfishing, on the other hand, is defined as the reduction of the fish stock below the level that yields maximum profits to the fishermen (or maximum rent to the society). Economic overfishing occurs at higher levels of fish stock than biological overfishing (under static conditions). Profit attracts new entrants into open-access fisheries until all profits (rents) are dissipated and a biologic-economic equilibrium is attained with no further changes in the industry or the fish stock, as long as static conditions prevail.

Table 7. Monthly average number of man-days[a] per household, Thailand.

	Fishing employment				Nonfishing employment				
	Total	Own fishing	Fishing labour	Fish processing	Total	Farming	Hired labour[b]	Other[c]	Total income
Chumporn									
Household head	17.25	13.16	4.09	0.00	1.21	0.41	0.57	0.23	18.46
Other members	14.51	8.36	4.41	1.74	5.86	2.28	1.99	1.59	20.37
Household	31.76	21.52	8.50	1.74	7.07	2.69	2.56	1.82	38.83
% of total	81.8	55.4	21.9	4.5	18.2	6.9	6.6	4.7	100.0
Nakhon									
Household head	13.62	11.33	2.26	0.03	2.25	1.12	0.31	0.82	15.87
Other members	9.67	6.41	2.92	0.34	4.63	0.82	2.25	1.56	14.30
Household	23.29	17.74	5.18	0.37	6.88	1.94	2.57	2.37	30.17
% of total	77.2	58.8	17.2	1.2	22.8	6.4	8.5	7.9	100.0
Trat									
Household head	19.55	16.06	1.41	2.08	0.58	0.31	0.27	0.00	20.13
Other members	18.57	9.80	0.59	8.18	5.83	1.18	1.56	3.09	24.40
Household	38.12	25.86	2.00	10.26	6.41	1.49	1.83	3.09	44.53
% of total	88.6	58.2	4.5	25.9	11.4	3.4	0.8	7.2	100.0
Pang Nga									
Household head	11.05	10.54	0.00	0.51	2.10	0.63	0.17	1.30	13.15
Other members	11.50	6.16	1.15	4.19	9.94	0.45	3.63	5.86	21.44
Household	22.55	16.70	1.15	4.70	12.04	1.08	3.80	7.16	34.59
% of total	65.3	47.3	3.3	14.8	34.7	2.6	4.7	27.4	100.0

[a]A man-day is defined as an 8-hour working day.
[b]Hired labour includes employment in mangrove cutting, charcoal production, fish processing, and carpentry as well as unskilled employement.
[c]Other includes the public service, food shops, boat management, tailoring, car driving, duck and cattle raising, shrimp farming, barbering, handicraft production, and retail fish trade.

prices paid are as important. The geographical location of the sites, especially their distance from Bangkok — the country's main international port, industrial city, and consumption centre — affects the transport costs of inputs and outputs as well as the degree of competitiveness in the markets for these commodities. Nakhon and Pang Nga are more than twice as far from Bangkok as Trat and Chumporn (see Fig. 1).[6] Moreover, the fishing communities in Pang Nga, being dispersed on small and remote islands, and those of Nakhon (Phak Panang district), located on an isolated peninsula, have very poor transport links with each other and the provincial capital. Smallness and isolation inhibit competition and social infrastructure, enhancing the role and bargaining power of the middlemen in the marketing of the catch, procurement of inputs, and provision of credit.

Differences in the composition of catch may also account for part of the income differentials among sites. Trat, because of its proximity to the underfished Kampuchean waters, landed the largest quantity and highest quality of "big shrimp" per household (25.0 kg/month sold at 144 THB/kg). The average households in Chumporn and Nakhon landed, respectively, 25.5 kg and 18.5 kg of the same species but of smaller size (selling for 105 THB/kg). In Pang Nga, "pink shrimp" was the highest-priced species (79 THB/kg) but only 16.8 kg were caught by the average household. In addition, the larger and more advanced gear, especially the trawl employed in Chumporn and Trat, contributed massive quantities of trash fish, shellfish, and miscellaneous species outside the reach of traditional gear. For instance, the average household in Chumporn landed a monthly catch of over 4000 kg compared to only 390 kg in Pang Nga.

In total, the average monthly income per coastal fishing household in the sample ranged between 1955 THB for Nakhon to 6313 THB for Trat (Table 6). These figures may be compared with the results from previous socioeconomic studies of coastal fishing households and with the performance of Thailand's industrial fisheries. In two recent surveys of traditional fishing communities, in Songkhla and Phattalung provinces, just south of Nakhon Si Thammarat,

[6]The approximate distances of the four project sites from Bangkok are Trat 390, Chumporn 500, Pang Nga 900, and Nakhon 1190 km. The inverse relationship between income levels and distance from Bangkok may not be entirely accidental.

monthly average fishing incomes per household were 2256 THB and 1518 THB (Thailand, Department of Fisheries 1978, 1980); a span that encompasses our results for the neighbouring traditional fishermen of Nakhon and Pang Nga. We calculated these averages using values on operating profit per household (by type of gear) reported in the source (Thailand, Department of Fisheries 1978, 1980). It should be noted that the variances were considerable: the few households operating bamboo screens in locations that they controlled (quasi-property rights) earned many times the incomes of the many households using gill nets, cast nets, and set bags.

In the case of the industrial fisheries, no data for fishing income per household, as such, were available. Instead, we use for the purpose of comparison the latest available survey of costs and earnings per vessel grouped by type of gear and size of vessel (Thailand, Department of Fisheries 1979; Panayotou 1980b). The average monthly operating profits[7] per vessel for 1977 ranged from about 9000 THB earned by the medium-size (14–18 m long) otter trawler to almost 200 000 THB earned by the giant (over 25 m long) otter trawler. Other types and sizes, such as the 18–25 m otter trawler and the 18–25 m pair trawler earned operating profits in the neighbourhood of 30 000 THB/month. Small (under 14 m) otter trawlers, common in the coastal fisheries of Chumporn and Trat, are reported by the survey to have just covered their operating costs during 1977. In contrast, small pair trawlers earned substantial profits, of the order of 30 000 THB/month, during 1977 but had had considerable losses a few years earlier.

Although the large differences in order of magnitude emphasize the precipitous dualism of the Thai fisheries, these comparisons are not perfectly legitimate. First, there are the differences in time, in unit of analysis, and in sampling techniques between the two surveys; second, it is not known to what extent the reported household incomes correspond to operating profits; and, third, there are substantial differences in capital invested and risk involved so that, even after appropriate allowances, any comparisons must be regarded with caution.

Nonfishing Income, Assets, and Employment

As discussed earlier, fishing incomes are supplemented from a variety of sources that we have referred to collectively as nonfishing. We have already described the distribution of household heads and members among these occupations (Tables 4 and 5). However, although virtually all coastal fishing households supplement their incomes and employment by taking up nonfishing occupations, the extent to which they engage in such activities depends not only on the need for such supplements but also on their availability and profitability vis-à-vis fishing. Moreover, we would like to know to what extent differences in nonfishing incomes among sites arise from differences in labour employment and capital assets or from location-specific characteristics such as the resource base and infrastructure, assuming, of course, similar levels of efficiency. The effects of nonfishing incomes on those originating in fishing are also of interest, especially as they relate to resource depletion.

Fishing households in Pang Nga devoted, on the average, 35% of their working time to nonfishing occupations (Table 7) from which they earned more than 45% of their income (Table 6). In contrast, households in Trat spent slightly over 11% of their working time on nonfishing activities from which they earned barely 5% of their income. This striking divergence is a reflection of the differing relative profitabilities of the two activities between the two locations. An 8-hour working day (1 man-day) of fishing earned the average household in Pang Nga 97 THB compared with 156 THB for 1 man-day of nonfishing activities; the equivalent values for Trat are 165 THB for fishing and 51 THB for nonfishing (see Table 9). In Chumporn and Nakhon, where the two activities are more evenly remunerated (albeit unequally between the two locations), 18% and 23% of the household's working time was allotted to nonfishing activities, respectively, earning 17% and 20% of the household's total income (Tables 6 and 7).

In absolute terms, nonfishing income ranged from 326 THB in Trat to 1868 THB in Pang Nga, a divergence that can hardly be explained by differences in employment and capital assets (Tables 7 and 8). Indeed the estimated current value of nonfishing assets (including land) was 15% lower in Pang Nga than in Trat and the number of working man-days only 85% higher, whereas nonfishing income was almost six times higher. The implication of this is that more

[7]Operating profit is defined as gross revenues minus cash operating expenses, i.e., depreciation and opportunity costs of capital and family labour have not been deducted.

Table 8. *Estimated current value (THB)[a] of household assets, Thailand.*

	Chumporn		Nakhon		Trat		Pang Nga		Total	
	Average	%	Average	%	Average	%	Average	%	Average	%
Fishing assets	**25996**	**26.9**	**10630**	**37.7**	**27256**	**35.5**	**6290**	**15.9**	**15726**	**28.4**
Boat	13139	13.6	5935	21.0	16125	21.0	2297	5.8	8248	14.9
Engine	5413	5.6	3712	13.2	9666	12.6	2494	6.3	4704	8.5
Mobile gear	6689	6.9	517	1.8	912	1.2	734	1.9	2141	3.9
Stationary gear	0	–	247	0.9	180	0.2	481	1.2	242	0.4
Other equipment	755	0.8	219	0.8	373	0.5	284	0.7	391	0.7
Nonfishing assets	**43907**	**45.5**	**7443**	**26.3**	**24577**	**32.0**	**20866**	**52.8**	**22679**	**40.9**
Land	40942	42.4	5148	18.2	21908	28.5	19437	49.2	20403	36.8
Transport machinery	1121	1.2	323	1.1	2387	3.1	360	0.9	845	1.5
Other business assets	160	0.2	1391	4.9	69	0.1	333	0.8	595	1.1
Livestock	1684	1.7	581	2.1	213	0.3	736	1.9	836	1.5
House and other consumer durables	**26587**	**27.6**	**10153**	**36.0**	**24999**	**32.5**	**12383**	**31.3**	**17057**	**30.7**
House	22824	23.7	9011	31.9	22866	29.7	9550	24.1	14655	26.4
Others[b]	3763	3.9	1142	4.1	2133	2.8	2833	7.2	2402	4.3
Total	**96490**	**100.0**	**28226**	**100.0**	**76832**	**100.0**	**39539**	**100.0**	**55462**	**100.0**

[a]20 baht (THB) = US$1.
[b]Includes furniture, refrigerator, gas stove, sewing machine, television and radio sets, electric fan, and others.

labour employment is available and that it is better-paid, 267 THB/man-day in Pang Nga compared with only 139 in Trat,[8] rather than that any ownership of capital and land accounts for this large difference in nonfishing incomes between these two unlike fishing communities, which are separated by religion, distance (1288 km), and level of development. This is in contrast to their also large (but reverse) difference in fishing-income levels, which are largely due to the differences in their fishing assets discussed earlier.

Both Pang Nga and Trat depend for their livelihood on open-access resources: solely on fishing in the case of Trat; fishing, mining, and tourism in the case of Pang Nga. In Trat, the response to the depletion of proximate fishing grounds has been the expansion to new fishing grounds through capital accumulation (larger boats, more powerful engines, and more advanced gear) as well as through more processing at home. Trat's dual proximity to Kampuchea and to Bangkok (relative to the other sites) meant, respectively, virgin fishing grounds for further expansion and a higher value for its catch due to better infrastructure, including fish-processing plants. In Pang Nga, the response to a similar problem of fish-resource depletion has been the diversification of income sources toward other resource-based occupations such as mining, mangrove cutting, and tourism, partly because of the availability of such alternatives and partly because of the unavailability of funds for expansion of fishing operations. A supplementary hypothesis is based on the alleged aversion of Muslim fishermen to long fishing trips away from home, which the expansion of fishing operations to new fishing grounds and the employment of distant-water trawlers would entail. To the extent, however, that they continue to rely on open-access resources, their incomes over the long term cannot be sustained at a level exceeding their opportunity cost, that is, what they could earn outside the resource-based sectors.

The situation in Chumporn and Nakhon is quite different. As farming and other business, mainly livestock, are the main nonfishing occupations, the ownership of capital assets (especially land) is a key determinant of differences in nonfishing incomes. Chumporn households, with nonfishing assets valued at three times those of Nakhon, earned twice as much income for the same number of working man-days (see Tables 6 and 7). Although wages per man-day of hired labour were about the same for the two sites, net income per farming man-

[8]This difference is not due to differences in the level of skills because virtually all wage-employment jobs in Pang Nga are for unskilled labour (see Tables 4 and 5).

Table 9. *Average net cash income (THB)[a] per man-day,[b] Thailand.*

	Fishing income				Nonfishing income				
	Total	Own fishing	Fishing labour	Fish processing	Total	Farming	Hired labour	Other	Total income
Chumporn									
Household head	231.81	283.30	66.15	0.00	102.35	174.30	62.27	73.38	223.37
Other members	46.91	44.50	52.66	43.94	143.34	139.12	68.91	242.50	74.64
Household	147.3	190.8	59.2	74.8	136.4	144.5	67.4	221.5	145.3
Nakhon									
Household head	124.19	132.08	85.31	74.82	146.34	133.74	383.94	73.57	127.33
Other members	27.24	11.71	55.32	79.09	31.97	68.21	26.40	20.97	28.77
Household	83.9	88.6	68.4	78.7	69.9	106.1	69.5	39.1	80.6
Trat									
Household head	209.46	221.68	140.01	162.47	132.15	126.59	138.69	0.00	207.19
Other members	119.16	173.22	48.27	59.55	42.42	83.43	32.56	31.71	100.79
Household	165.5	203.3	112.9	80.4	50.7	92.6	48.2	31.7	148.9
Pang Nga									
Household head	146.80	146.17	0.00	154.58	234.87	126.37	620.87	188.89	162.18
Other members	49.50	49.57	31.72	54.27	135.84	50.14	232.04	79.25	88.65
Household	97.8	110.5	31.7	71.0	155.7	99.1	267.8	99.8	117.7

[a]20 baht (THB) = US$1.
[b]A man-day is defined as an 8-hour working day.

day and other business was considerably higher in Chumporn (see Table 9). Not surprisingly, income from hired labour accounted for only 18% of nonfishing income in Chumporn but for 37% in Nakhon (see Table 6).

The relatively high opportunity cost of fishing in Chumporn acts as a barrier to entry into the open-access fisheries, thus keeping incomes at a level twice that of the isolated communities of neighbouring Nakhon. Geographical isolation and occupational attachment, coupled with paucity of employment opportunities elsewhere and risk aversion at a subsistence level, act to inhibit mobility and preserve regional income differentials.

Comparative Incomes

Having obtained fishing and nonfishing incomes, it is a matter of simple aggregation to arrive at the total household income in each site: Trat 6640 THB, Chumporn 5643 THB, Pang Nga 4111 THB, and Nakhon 2432 THB (Table 6). These figures, although suspected to be gross of certain costs, provide a clear picture of the relative income positions of fishing households among sites. Nakhon is by far the poorest site with only 37% of the average income of Trat and 43% of that in Chumporn. Pang Nga, despite a fishing income not significantly different from Nakhon, enjoys a total income twice as large because of high nonfishing earnings.

Because incomes reported directly can be over- or under-estimated due to failure to subtract certain costs and to the fear of taxation respectively, net fishing income was also computed from the cost and earnings data analyzed in a separate study (Panayotou et al., this volume, p. 163).

The results so obtained are reported and compared to those reported directly by the fishermen (Table 10). Fishermen at all four locations were found to have underestimated their fishing incomes but the difference was within the range of reasonable error, except in Chumporn where the reported income was less than half the computed income. It is not unlikely that the fear of taxation was behind this disparity: Chumporn is a relatively wealthy province with fertile land and relatively rich fishing grounds that is not too far from Bangkok and hence accessible to the tax officials.

Unfortunately, there was little information on net household incomes of other socioeconomic groups, such as farmers, with which comparison could be made. The crop year 1975–76 is the most recent year for which statistics on farming incomes are available. We use instead the national, regional, and provincial net household incomes for 1978 to establish the relative income position of coastal fishing households in the country, the region, and the province where they are located (Table 10).

Chumporn fishermen, regardless of whether the reported or computed income was used,

Table 10. Comparison of total income (THB/month)[a] of fishing households to provincial, regional, and national averages, Thailand, 1978.

	Southern region			Eastern region
	Chumporn	Nakhon	Pang Nga	Trat
Fishing				
Computed[b]	10089	2115	2565	7617
Reported[c]	4680	1955	2244	6313
Nonfishing	963	477	1868	326
Total				
Computed	11052	2592	4432	7943
Reported	5643	2432	4112	6639
Average[d]				
Provincial	4997	3265	15019	5649
Regional		5092		9545
National			4445	

[a]20 baht (THB) = US$1.
[b]Income computed from survey data.
[c]Income reported by fishermen.
[d]Income computed from NESDB (1979).

were better off than the national, regional, and provincial averages: in fact, if the computed income is accurate they were more than twice as well off as the average Thai. It is tempting to conclude that Chumporn fishermen can stand on their own and need no government assistance. However, as averages are often deceiving a look at income distribution is necessary. From the *Analysis of Cost Structure and Profitability* (Panatoyou et al., this volume, p. 163), it was found that fishing households using medium-scale types of technology, such as purse seines and fish gill nets, averaged 16773 THB/month compared with only 3252 THB/month by such small-scale fishing gear as cast net and crab gill net. In fact, without the purse seine, which earned over 78000 THB/month, the computed income of Chumporn fishermen would have been just about equal to the national average. Thus, it is the small-scale fishing units and the medium-scale trawl that require government assistance.

Similarly, fishing households in Trat had total incomes above the provincial and national averages but below the regional average of 9545 THB/month. It is, again, the medium-scale gears such as shell rake, trawl, and push net that had the high incomes, averaging 18244 THB/household, compared with only 2427 earned by small-scale gear such as fish gill net and crab trap (see *Analysis of Cost Structure and Profitability*, p. 163).

The average total income of Pang Nga fishermen was found to be just below the national and regional averages but not even 30% of the provincial average. The latter is to be expected since Pang Nga has the second highest provincial income per person among Thailand's 72 provinces, because of its rich mineral resources, particularly tin. Thus, although fishing households in Pang Nga may not be in absolute poverty, they may feel poorer than any other part of the province in terms of relative income. It should also be taken into account that virtually all fishermen surveyed in Pang Nga turned out to be small-scale operators earning total fishing incomes of 625–4233 THB/month. It was only by hiring out their labour to the tin mines or by engaging in illegal offshore dredging that many managed to eke out a living. Pang Nga was the only location where nonpowered fishing units were encountered, where no medium-scale units were found, and where most fishermen were using an assortment of gear types, although this may be partly due to the morphology of the fishing ground.

Fishing households in Nakhon were earning on the average only about 50% of the national and regional averages, but only 25% below the provincial average. Except for a few households who were operating a combination of trawl net and gill net and earned about 5000 THB/month, all other households, regardless of the scale and type of gear operated, were worse off than the average household in the country. There were also a few groups of households, especially those operating traditional types of gear, such as set bag nets and winged set bags, whose total fishing and nonfishing income was below the rural poverty line, defined as 1250 THB/month per household (based on World Bank [1979] values that give the poverty line as 1981 THB/person per year in 1975–76 prices; adjustment was made for inflation between 1975 and 1978).

Standards of Living

The standard of living of a household depends largely on its disposable income relative to its size as well as on the availability of public services and social amenities. The disposable cash income is the sum of fishing and nonfishing incomes earned by the household minus taxes paid.

Disposable household income is not very different from total income because taxes from and transfers to coastal fishing communities are insignificant. According to Table 11, taxes ranged between 2.4 THB/month in Pang Nga and 15.5 THB/month in Chumporn. (Donations, especially to temples, were far more

Table 11. *Monthly household cash expenditures (THB),[a] Thailand.*

	Chumporn		Nakhon		Trat		Pang Nga		Total	
	Average	%	Average	%	Average	%	Average	%	Average	%
Food[b]	**1260.74**	**56.9**	**1231.78**	**68.3**	**1553.30**	**62.6**	**1047.65**	**59.7**	**1237.23**	**62.0**
Rice	326.76	14.7	306.46	17.0	309.84	12.5	326.04	18.6	317.25	15.9
Other	724.45	32.7	783.92	43.5	1099.34	44.3	559.41	31.9	755.79	37.9
Drink, etc.	209.53	9.5	141.40	7.8	144.12	5.8	162.20	9.2	164.18	8.2
Nonfood[c]	**954.25**	**43.1**	**570.43**	**31.6**	**927.42**	**37.4**	**708.23**	**40.3**	**757.00**	**38.0**
Charcoal and cooking fuel	85.16	3.9	23.96	1.3	95.52	3.8	14.57	0.8	47.27	2.4
Gasoline for home	46.51	2.1	41.19	2.3	41.71	1.7	42.67	2.4	42.97	2.2
Clothing	144.14	6.5	157.16	8.7	174.45	7.0	141.54	8.1	152.29	7.6
Transport and food outside	163.86	7.4	97.01	5.4	95.93	3.9	110.98	6.3	116.97	5.9
Medical care	147.85	6.7	66.04	3.6	155.09	6.3	71.89	4.1	101.25	5.1
Utilities	34.16	1.5	31.37	1.7	73.67	3.0	146.43	8.3	70.45	3.5
Education	140.03	6.3	86.70	4.8	160.95	6.5	82.07	4.7	109.82	5.5
House repairs	53.91	2.4	28.92	1.6	48.05	1.9	20.12	1.2	35.51	1.8
Donations	120.86	5.5	28.35	1.6	72.90	2.9	75.44	4.3	70.79	3.5
Taxes and fees	15.52	0.7	6.64	0.4	6.35	0.3	2.35	0.1	7.57	0.4
Other	2.25	0.1	3.09	0.2	2.80	0.1	0.17	0.0	2.10	0.1
Total	**2214.99**	**100.0**	**1802.21**	**100.0**	**2480.72**	**100.0**	**1755.88**	**100.0**	**1994.23**	**100.0**

[a]20 baht (THB) = US$1.
[b]The average monthly noncash expenditures on food (e.g., from own produce) per household, based on fishermen's estimates, were: Chumporn 172, Nakhon 62, Trat 66, and Pang Nga 73 THB.
[c]The average monthly noncash expenditure on nonfood (mainly charcoal and fuelwood) per household, based on fishermen's estimates, were: Chumporn and Nakhon 17 each, Trat 6, and Pang Nga 3 THB.

significant, ranging from 28.4 THB in Nakhon to 120.9 THB in Chumporn.) Disposable income per person can then be obtained by dividing household income by average family size (see Table 2) and this can then be compared to the national average. Trat with 1143 THB and Chumporn with 866 exceed the national average of about 629 THB (NESDB 1978) whereas Pang Nga with 587 THB and Nakhon with 367 THB fall short of this national average. The per-person disposable income values for all four sites are based on the "reported" rather than "computed" household incomes (see Table 10).

Alternative or rather supplementary to income indicators of standard of living are the ownership of consumer durables and the private consumption expenditure. According to Table 8, the estimated current value of consumer durables (including house) ranged between 26 587 THB in Chumporn and 10 153 in Nakhon; Trat was somewhat below Chumporn and Pang Nga somewhat above Nakhon. As this value may reflect the value of the land in each location more than the conditions of living, a better indicator might be the value of consumer durables excluding house, such as furniture, refrigerator, sewing machine, and television and radio sets. Again, Chumporn with 3763 THB/household in such assets turns out to be the wealthiest site and Nakhon with only 1142 THB, the poorest. Somewhat surprisingly, the average household in Pang Nga owns consumer durables (especially radios and televisions) of a somewhat higher total market value than its counterpart in Trat, possibly because of the opportunity for smuggling from Malaysia and Singapore.

In terms of private consumption expenditure (Table 11), Chumporn and Trat had substantially higher total expenditure than Nakhon and Pang Nga but, as expected, the gap was much narrower than in the case of income; not only biases in reporting are fewer but also expenditures correspond more closely to needs than to opportunity; and needs, unlike opportunities, are to a large extent common among households. Unlike income, consumption expenditure per household appears substantially lower than the national average: even Trat with the highest expenditure, 2481 THB/household, falls short of the national average of 3075 THB (NESDB 1978). (Note that figures exclude the purchase of consumer durables.)

Expenditures on food in Nakhon and Chumporn are about equal despite the considerable differences in total expenditures and even greater differences in incomes between the two sites. Even more striking is the virtual equality of expenditures on rice across sites, between 307 and 327 THB/month, which may be compared to the national average of 400 THB/household (NESDB 1978).

Expenditure on food as a percentage of total household expenditure, known as the Engel's coefficient, is another important indicator of standard of living: the poorer a family or a nation, the larger is the percentage of expenditure that must go to food — at the limit, a very low income may be spent entirely for biological survival. As income rises, an increasing proportion of expenditure goes to other, less mandatory, items such as clothing, transport, and education. An Engel's coefficient of 50% is sometimes used as a dividing line between developing and developed countries. According to Table 11, all four sites have Engel's coefficients considerably above 50%, with Nakhon the highest at 68.4%, and Chumporn the lowest, 56.9%. Somewhat surprisingly, Trat with the highest total expenditure among all sites, and the lowest percentage expenditure on rice and drinks, had the second highest Engel's coefficient, 62.6%, because of unusually high expenditures on other foodstuffs, such as meats, dairy products, and vegetables. Pang Nga, with only half the expenditure of Trat on these items and the lowest among all sites, had a coefficient of 59.7%. Differences in religion, distance from Bangkok, and sources of income may account for this reversal between Trat and Pang Nga. Households in Trat being Buddhist, located not far from Bangkok, and deriving virtually all their income from fishing (with few noncash income sources) may indeed spend considerably more on semiluxury food items such as meats, dairy products, and imported foods. The Engel's coefficient for the country as a whole in 1978 was estimated to be 56.7%, suggesting that no site except Chumporn enjoyed a standard of living close to the national average (NESDB 1978). (Note that food consumption here includes beverages and cigarettes and the total consumption expenditure excludes consumer durables.)

In terms of nonfood expenditure, the most remarkable differences among sites were those on charcoal and cooking fuel, utilities, medical care, and education. Expenditures on charcoal and cooking fuel were considerably lower in Nakhon and Pang Nga, not only because of lower food consumption, but also because of the availability of free fuelwood from mangrove forests, which are abundant in these two areas. The communities in Pang Nga had the highest expenditure on utilities per household because their location (small, dispersed islands) precludes economies of scale in the provision of utilities, including water, which must be brought from outside. Medical care and education, because of a presumably higher-than-unity elasticity of demand, command a larger absolute and proportionate expenditure in Trat and Chumporn than in the lower-income sites of Nakhon and Pang Nga.

Unlike inter-country comparisons, differences in public services and social amenities among rural households within a given developing country are often closely related to differences in incomes, as well as to the distance from the urban centres, especially from the national capital. This was certainly the impression of the interviewers who lived and worked in these communities for almost a month. The results of the evaluation of the public services by the fishermen themselves were similar: 70% of all households in Trat regarded these services as satisfactory compared with 56% in Chumporn, 53% in Pang Nga, and 47% in Nakhon. In terms of specific services, only 3% of the households in Pang Nga had electricity compared with 42% in Trat. Only 1% of the households in Nakhon was provided with community water supply compared with 33% in Chumporn.

Summary and Policy Implications

The objective of this paper was to give a cross-sectional profile of income conditions and standards of living of coastal fishermen in Thailand based on preliminary results of a socioeconomic survey at four fishing communities. It was found that the all-Buddhist, centrally located communities of Chumporn and Trat had considerably higher incomes than the all-Muslim relatively isolated communities of Pang Nga. However, location rather than religion appears to have been the crucial factor because the two-third Buddhist/one-third Muslim but very isolated communities of Nakhon had the lowest incomes and standards of living on every count. Differences in fishing incomes among sites appear to be explainable by differences in fishing assets whereas nonfishing incomes are more closely related to the availability of labour employment and arable land than to nonfishing capital. Besides the larger fishing incomes in the former two sites, it is also worth noting the importance and profitability of fish processing in Trat, of farming in Chumporn, and of mining and hired labour in Pang Nga. When judging welfare on the basis of household consumption expenditures rather than incomes, Nakhon continues to have the lowest standard of living, much below the national average, whereas Chumporn has the highest, approaching the national average. Pang Nga and Trat fall somewhere between but their relative ranking remains indeterminate.

Thus, of the four surveyed locations, Nakhon with the largest sample and lowest income requires the largest and most urgent assistance, followed by the "true" small-scale fishing units of all other three locations. Because the factors behind the low standards of living in Nakhon are the open-access status of the fishery combined with a limited fishing range, the lack of nonfishing alternatives, and the geographical isolation, only regulation of access in concert with creation of alternatives and encouragement in mobility can change Nakhon's depressed socioeconomic status.

Helping fishermen to increase their fishing range through capital subsidies or other means may be the only choice available in the short run, but is should be treated only as such and not as a lasting solution. The Gulf of Thailand is already heavily overfished and continuing open-access fishing with subsidies promises to worsen things even faster than has been the case in the past. Promotion of more processing at home, without regulation of access to the resource base, is also doomed to failure despite its current success in Trat and its potential as a relief measure for Nakhon.

In fact, the proposed policies are as relevant to Trat and Pang Nga as they are to Nakhon, though probably not as urgent. Fishing households in Trat depend perilously for over 95% of their income on fishing-related activities, themselves dependent on an open-access resource that is also vulnerable to the fluid political situation in Kampuchea. Pang Nga, despite the diversification of income sources afforded by mining, mangroves, and tourism, is not immune as these are also open-access, depletable resources that can hardly be relied upon for a sustained improvement of living conditions. In the long run, only comprehensive rural development and enforced fisheries-resource regulation can free resource-based communities from their predicament of eventual decline.

Socioeconomic Conditions of Small-Scale Fishermen in Sri Lanka

Hemamala Munasinghe[1]

The disintegration of the politico-economic control over the small-scale fishery held by the traditional coastal elites of *madel* (beach-seine) owners and technological developments such as the motorization of the small-scale fishery were processes that accompanied as well as followed the radical political and social changes of 1956. These processes paved the way for a subsequent course of development along which the small-scale fishery has continued to move. As a result of this course of development, the small-scale fishery has emerged today as one of the important income-generating sectors within the rural economy.

In this paper, the present social and economic conditions of Sri Lankan fishermen are discussed against the background of the production system and the infrastructure pertaining to the fishing industry. Among the socieconomic aspects of the small-scale fishermen considered are their demographic and income structure, their expenditure and investment patterns, and their assets and liabilities. A comparison is made, wherever possible, of their standard of living to that of other socioeconomic groups in the country, for example, the agricultural peasants.

More specifically, the purpose of this paper is fourfold:

- To provide an overall picture of the structure, activities, and standards of living of small-scale fishing villages and households;
- To compare the standards of living of small-scale fishing households with those of other socioeconomic groups in the rural sector (e.g., farmers) to assess their relative positions in the rural economy;
- To identify the factors that account for any differences in the standards of living among small-scale fishing households themselves and between them and other socioeconomic groups to provide a basis for formulating effective policies for assistance and development; and
- To investigate the savings and investment patterns of fishermen to assess whether capital generated from the fishing industry is reinvested in the industry itself or moves out to develop the nonfishery sectors of the rural economy.

To determine any changes in the socioeconomic conditions of small-scale fishermen, a set of time-series data would be necessary. However, because such data are not available for the fishery sector in Sri Lanka, the paper is confined to a cross-sectional analysis of the social and economic conditions of fishing communities. To compare standards of living of fishing households with those of other sectors of the rural economy, comprehensive socioeconomic data for the other rural sectors would be required and such data should also be comparable in time. However, such recorded data pertaining to most aspects of socioeconomic life (e.g., consumption patterns, production levels, nutrition levels, savings and investment patterns, and housing conditions) are not available for nonfishery sectors of the rural economy for the current period, and this has constrained the scope of the comparative analysis. It has been possible to compare the fishery and nonfishery sectors only in terms of household income levels — the most commonly used measurable and manageable, although not perfect, indicator of living standards.

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Methodology and Data Collection

Two basic units of analysis are used: the "fisherman" and the "fishing household." The basic dependent variable or fact to be explained is the standard of living or the household or individual income from all sources (fishing and nonfishing) and in all forms (cash and noncash). Net disposable income is used, i.e., depreciation charges and taxes having been deducted from and subsidies added to gross income and the family size taken into account. However, income alone is not a satisfactory index of welfare. Alternative measures of standard of living, such as consumption patterns, type of houses, education levels, and Engel's coefficient (ratio of expenditure on food to total expenditure), are also used to provide a more comprehensive measure of the standard of living.

Through the use of these various indicators, we determined the standards of living of fishing households both in absolute terms and in relation to one another and we attempt to show how fishing households compare with other groups in the rural sector. Thus, in defining and measuring our dependent variable, standard of living, we describe in both an absolute as well as a comparative way several conventional socioeconomic variables: income structure, occupational structure, family size, age structure, fishery and nonfishery sources of income, consumption expenditure, education levels, and savings and investment patterns. Through a description of these variables, we establish how well off, or otherwise, the fishermen are with respect to each other and with respect to comparable sectors of the Sri Lankan rural society.

Because secondary data were not available on the socioeconomic conditions of small-scale fishermen in Sri Lanka, primary data had to be collected in the field. This was done in two phases. First, exploratory research was conducted to gather basic data about fishing communities in 17 fishing centres (marine, lagoon, and inland) through the following techniques: participant observation, administration of simple questionnaires, case studies, and interviewing government officials and other persons knowledgeable about the Sri Lankan small-scale fishery. The choice of project villages was conditioned by such factors as technology, marketing patterns, ethnic composition, and religious affiliation. The communities were thus selected to represent a cross-sectional profile of the small-scale fishing communities in the island. On the basis of data gathered during this phase, explanatory hypotheses were generated. These were tested in a second phase through a sample survey in which data were collected largely through the administration of questionnaires. A multistage stratified system was used to select 21 fishing villages:

- The population under investigation was first stratified according to the resource base into marine, lagoon, and inland.
- The primary strata were further stratified into fishing villages, which can be considered as secondary strata.
- Villages were then selected for purposive sampling on the basis of the objectives of the study, using as the main criterion the respective importance in each village of the different types of technology (types of craft and gear) and the different patterns of fish marketing.
- A list of craft owners, crew members, and traders of the various types for each of the purposively selected villages was constructed through a village-level census; those to be sampled were randomly selected from these lists.
- The number of craft owners and crew members of each type and the number of middlemen or traders of each type selected depended on the sample size and on the population of each craft–gear and middleman–trader type at each purposively selected centre.

The selection ensured that virtually all types of resource base, all types of technology, all religious groups, ethnic groups, geographical regions, and marketing patterns were represented in the sample. Thus, a cross-sectional representation of small-scale fishing centres in Sri Lanka was selected for study.

For each type of technology and each type of middleman–trader, a 10% random sample was selected and for every craft owner selected, a crew member was also selected. It was also decided that, for each sample category, a minimum of 20 respondents would be sampled, wherever feasible, to provide reasonable representation. Thus, the interviews covered a sample of craft owners, crewmen, beach assemblers and fish retailers representative of the various socioeconomic facets of the small-scale fishery. Community leaders from each of the project sites were also interviewed to obtain an overall view of the fishery at each of these centres. In all, data were collected from 1230 "units" that comprised the total sample.

Four questionnaires were formulated for collecting the required information: they were pretested, suitably modified, and then administered to the selected sample. The coded data were tabulated and analyzed. At the same time, macrolevel data pertaining to production levels, fleet size, physical and institutional infrastructure, etc. were obtained from the Ministry of Fisheries and the annual report of the Sri Lanka Central Bank (1979): these data provide a backdrop to the study of socioeconomic conditions of small-scale fishermen.

Before reporting our empirical findings on the socioeconomic conditions of small-scale fishermen, based on our primary data collection, we provide an overview of the Sri Lankan fishery sector based on secondary data as a background against which our findings and policy recommendations should be viewed.

Overview of the Sri Lankan Fishery Sector

Structure and historical developments

Sri Lanka, an island of about 65 600 km^2 at the tip of the Indian Subcontinent, has a continental shelf about 32 km wide at its broadest point, around the northwestern coast, narrowing to about 8 km at the south coast. The island has a coastline of about 1200 km along which a large number of rivers, lagoons, bays, and estuaries are found. Further inland, a considerable number of lakes and artificial reservoirs are also found. These bodies of water provide an ample potential for a flourishing fishing industry in the country: only part of this potential is being utilized at present. Although exploitation of these waters continued throughout the ages more or less as a village activity, organized fishing developed as an industry only in the last few decades. In 1979, the fishing industry provided employment to only 2.2% of the total labour force of the country.

Despite considerable development assistance during the last two decades, the fishing industry has not progressed beyond the scope of a small-scale industry: its contribution to the gross national product (GNP) in 1979 was only 2.8% in contrast to the 22.4% provided by the agricultural sector. In a country with a population of nearly 15 million, an annual growth rate of about 1.6%, and a GNP of 48 885 million LKR (15.63 rupees [LKR] = US$1), calculated at current factor-cost prices, this contribution is rather small (Sri Lanka, Central Bank 1979).

Fish production and consumption

Of the 165 720 tons assessed by recent surveys as the production for 1979, 88.4% came from inshore or coastal fisheries (0–40 km range) including lagoon fisheries, 10.3% was from inland freshwater fisheries, and 1.3% from offshore fisheries (40–80 km). Of this total production, only 6230 tons were exported. In addition to the local production, a wet weight equivalent of 25 140 tons of fish was imported. The total supply of fish was, therefore, 184 630 tons (Sri Lanka, Ministry of Fisheries). Based on the average production for each type of craft used in the industry, the Marga Institute has calculated the supply of fish for 1979 to have been 189 370 tons.

The fisheries products exported were mainly crustaceans (prawns and lobsters). The export of these products had increased gradually throughout the 1970s and, by 1978, it was 225% higher than the 1975 figure. Foreign exchange earnings also rose, by 910% during the 1975–78 period (Sri Lanka, Ministry of Fisheries). This trend, however, was constrained by an export ban on lobsters introduced by the government in September 1979 in an attempt to protect the lobster resource from what was assessed as a rapid depletion.

Per-person fish consumption for Sri Lanka, which was 14.5 kg in 1972, was reduced to 11.3 kg in 1978 despite an increase in fish production during the period. This was due to the 10% increase in population and to the severe curtailing of fish imports during this period. Since 1978, the increase in both imports and production has resulted in an increase in per-person fish consumption by 15% to 13.2 kg by 1979 (Sri Lanka, Ministry of Fisheries). There is still a strong cultural preference for marine fish over freshwater fish.

Motorization and modernization of fishing fleet

Until the introduction of mechanized boats in 1959, the fishermen went out to sea in traditional craft with or without a sail. On a coastline of only 1200 km, the wide variety of gear and craft is surprising at first glance. Careful study of the craft and the groups of fishermen that use particular types of craft reveals that, on the southern and lower western coasts where the majority of the fishermen were Sinhala Buddhists, the outrigger canoe or *oru* was preferred, whereas Sinhala Roman Catholics in the upper western and northwestern coast favoured the small log craft or *teppam*. The Tamils on the northern coast and the Muslims in the eastern coast used the large log raft or *kattamaran* and the dugout canoe or *vallam*.

The 1959 experiment of introducing mechanized craft to the fishing industry was not accepted with much eagerness or enthusiasm by the fishermen. However, when this same innovation was further encouraged in 1965 with such added incentives as the provision of nylon nets and more powerful engines, it was accepted more enthusiastically and, today, the 3.5-ton type boat is widely used in Sri Lanka. Despite the enthusiasm shown for the new craft and fishing gear, the fishermen still had the problem of capital outlay. When the lighter and less costly 17.5-foot fibreglass boat with outboard motor was introduced by the government, it proved to be popular chiefly among the western and northwestern coastal fishing population. This new craft had the added advantages of lower running costs and no special anchorage requirements.

Of the fibreglass boat and outboard motor combination, the power unit was soon found to be adaptable even to traditional craft and its popularity continued to grow: a greater number of traditional craft than 17.5-foot fibreglass boats are now operating with outboard motors. That mechanization has become more broadly based is also evident from the fact that 63% of the inshore marine fishery production is obtained through mechanized craft. Ministry of Fisheries' figures for 1979 showed that, of the country's fishery fleet of 25 610 units operating in the inshore belt (16–40 km range), there were 2870 3.5-ton (28–32 foot) boats; 3970 fibreglass 17.5-foot boats with outboard motor; 4580 indigenous craft with outboard motor; and 14 190 nonmechanized indigenous craft. Despite considerable progress in mechanization of the fishing fleet, 55% of it is still traditional nonmechanized craft bringing in 37% of the total catch, and 14% of this is still derived from the traditional beach-seine technology (Sri Lanka, Ministry of Fisheries).

The craft used in the traditional beach-seine fishery is not actively engaged in the catching of fish, rather it is used to take a large net several hundred metres out to sea, leaving one end of the net on the beach, encircle shoals of varieties of small fish, and then bring the free end back to shore. The net is then pulled into shore to trap the fish. In 1975, this method of production was responsible for 30% of the total catch. With the popularity of new technologies and mechanized craft, this system has become less popular and its share of production dropped to 9% by 1978 and to 5% in 1979.

Other types of technologies in the premechanization period consisted of handlines, troll lines, hand nets, cast nets, traps, and nets made with cotton thread. Although these technologies are still used to some degree, a new type of technology has become very popular among the fishermen. This is the drift net, made of nylon thread in various mesh sizes, which was introduced around 1962.

The nylon drift net boosted the production levels of the small-scale fishery by yielding a higher rate of return than the "longlines" used with the 3.5-ton boat in the first phase of mechanization. This technology yielded a higher rate of return, while requiring only a limited knowledge of the sea and the resource, unlike longlines or handlines for which an assessment of the location of demersal fish is necessary. The inability to find suitable bait and the extra expenses involved in doing so resulted in adopting drift nets in the place of longlines. This technological change resulted in increasing production throughout the island and especially in the areas benefiting from mechanization — particularly the southern and western provinces.

Related industries

The dry-fish production industry, which prospered before the introduction of refrigeration and deep-freezing techniques for preserving fish and the development of fish transport, has declined during the last two decades. Although 29% of the fish produced was converted to dry fish in 1959, only 9% of the production was converted to dry fish in 1978 (Fernando 1979). Faster transport and the consumers' preference for fresh fish, which is easily available, may also be responsible for the industry's decline. The demand for fresh fish has created a demand for ice for temporary preservation during transport and the manufacture of ice for this purpose is an industry in itself.

Six fishery harbours have been constructed, two others are under construction, and plans have been drawn up for the construction of three more harbours. The harbours are provided with storage facilities, cold rooms, ice plants, and workshops for maintenance and repair of fishery craft.

Socioeconomic Conditions of Small-Scale Fishermen

Sociodemographic profile

Of a Sri Lankan population of around 15 million, about 580 000 people are dependent on the fishing industry: 68 000 of them are active fishermen, 14 500 are engaged in secondary sectors, and 497 000 are family members and dependents. The secondary sector includes

Table 1. Distribution of population by ethnic group and religion, Sri Lanka, 1971.

Race	% of population	Religion	% of population
Sinhala	72.0	Buddhist	67.3
Tamil	20.5	Hindu	17.6
Moors	6.9	Muslim	7.1
Malay	0.3	Roman Catholic Christian	7.1
Other	0.3	Protestant Christian	0.8
		Other	0.1

Source: Sri Lanka, Department of Census and Statistics (1971).

Table 2. Distribution of marine and lagoon fishermen by religion and caste, Sri Lanka, 1980.

Religion	% of fishermen	Caste	% of fishermen
	Sinhala		
Buddhist	22.8	Karawa	44.3
Roman Catholic		Govigama	1.4
Christian	31.0	Salagama	3.0
Protestant		Durawa	5.3
Christian	0.2		
	Tamil		
Hindus	21.0	Karayar	34.4
Roman Catholic		Other	1.7
Christian	14.5		
Protestant			
Christian	0.6		
	Moors and Malay		
Muslim	9.9	–	9.9

Source: Marga Institute (1980a).

distribution, marketing, production of fishing gear, and assembly, maintenance, and repair of engines.

In the multiracial and multireligious society of Sri Lanka, each race virtually represents a distinct religious group. The majority of Sinhalese are Buddhists, Tamils are Hindus, whereas Moors and Malays follow the Islamic faith (Table 1). Religion and race appear to have influenced the choice of fishing as a vocation: more Catholics and Hindus are engaged in fishing than Buddhists (Tables 1 and 2). Although 67% of the total population are Buddhists, only 23% of the fishing population belong to this religion. The 18% Hindus and 7% Catholics account for 21% and 46% of the fishing population respectively. The Buddhist precept against the taking of life may have acted as a barrier to the Buddhists entering the fishing industry, a hypothesis investigated by Fernando et al. in another study in this volume (p. 205).

Table 3. Distribution of fishermen (%) by age Sri Lanka, 1980.

Age	Craft owners	Crew members
15–25	13	44
26–35	33	31
36–45	26	14
46–55	15	8
Over 55	13	3

Source: Marga Institute (1980a).

It is difficult to determine whether a vocation was a prelude to segregation in a caste or vice versa. However, a survey of the distribution of the fishing population in terms of caste is most revealing. Both in the Sinhalese and Tamil communities, the caste system is still very active and one particular caste in each community appears to dominate the fishing industry (Table 2), probably not through choice but as an economic heritage. Fishing as a vocation is practiced by the Karawa caste in the Sinhala community and the Karayar in the Tamil. Of the country's fishing population, 44% are from the Sinhala Karawa caste, 34% from the Tamil Karaya caste, and 11% from other castes; the remaining 10% are Muslims.

Most of the crew members (75%) were under 35 years old whereas a majority of craft owners (54%) were over 35 years old (Table 3). This age structure may be explained by the requirement for physical fitness of the work as crew or by lack of adequate capital at a young age to purchase a fishing craft. The lower average age of crew compared to that of the craft owners suggests that, with experience and gathering of capital during the early years, crew members advance to become owners of craft.

The average size of a fisherman's family in the marine and lagoon fishery sectors was 6.8 members and in the inland fishery sector 5.8 members. Unlike the situation in other rural sectors where large families are found among lower income groups, in the fishery sector there is a positive correlation between family size and higher income groups. The larger the family, the more members are engaged in fishing, hence the higher the family income. The average number of persons employed per household is 1.5 in marine and lagoon fisheries and 1.3 in inland fisheries.

Formal female employment in fishing is almost nonexistent. However, women in Roman Catholic and Muslim–Hindu fishing villages find informal employment in marketing, distribution, and processing and salting of fish, as

Table 4. Level of education (% of population) in various occupations in the rural community, Sri Lanka, 1980.

Occupation	Illiterate	Grade 1–4	Grade 5–8	Grade 9–12	Technical education
Fishermen					
Traditional craft	41	19	33	7	0
Mechanized craft	3	22	58	16	1
Agricultural and general labour	5	21	54	20	0
Manual workers[a]	2	5	57	36	0

Source: Marga Institute (1980b).
[a]Includes drivers, carpenters, and masons.

unpaid family labour. Buddhist women, however, do not undertake any activity concerned with the fishing industry. About 65% of the fishermen interviewed were married. Of these, 90% were household heads and the main income earners. As many as 77% of fishing households were run by women who were responsible for decision-making. Control of the family purse was in the hands of the wife or mother as far as daily expenses were concerned, but when major decisions had to be taken with regard to investments or reinvestments in the fishing industry, the male usually took over from the wife or mother.

Only 9% of the over-15 age group of fishermen were found to be illiterate. Only 3% of those using mechanized craft were illiterate compared with 41% of those using traditional craft (Table 4) and traditional craft were more common among the older generation. With the island-wide education programs launched by successive governments, the fishing community has benefited: 41% of the 15–20 year age group in the fishing community have had secondary education and not more than 3% of this age group was found to be illiterate.

Absolute and relative fishing incomes

The crew consists of hired labourers and one member who is not "hired" but is usually the owner of the vessel or fishing gear, or both. Payment to the crew is usually in the form of a share of the catch, in cash as well as kind (fish), after the cost of fuel and food and the share of the owner have been deducted. Hence, the income of the fishermen, both owner and crew members, is variable and depends on the volume of the catch, fish prices, and running costs. The value of catch, in turn, depends on the size and type of the catch, which depends on the type of craft and gear used and the skill and time spent

Table 5. Annual net income (LKR)[a] by type of craft, Sri Lanka, 1980.

Type of craft	Craft owners	Crew members
Traditional craft (marine)	18828	8535
Traditional craft with outboard motor	32338	17584
17.5-foot fibreglass boat with outboard motor	46026	20132
3.5-ton mechanized boat	79182	21428

Source: Marga Institute (1980a).
[a]15.63 ruppees (LKR) = US$1.

fishing as well as on factors beyond the control of the individual fisherman, such as the weather, availability of resources, and competition from other fishermen. Almost 94% of boat owners and 92% of crew members derived their entire household income from fishing, the rest derived at least 50% of their income from fishing.

Incomes derived from each type of craft varied (Table 5). There is no doubt that the net income derived from a mechanized craft is greater than that from a traditional craft and, among the mechanized craft, the 3.5-ton boat provides, by far, the greatest net income. Small wonder, then, that the 3.5-tonner has gained popularity in recent years.

The ratio of income from a 3.5-tonner to the income from a 17.5-foot boat is 1.7 : 1 for owners and 1.1 : 1 for crew members. The ratio of income from the traditional craft with motor to the traditional craft without motor is 1.7 : 1 for the owner of craft and 2.1 : 1 for the crew.

There is also evidence that the income of a fisherman depended on the type of fishery resource that he was exploiting. The marine fishery provides more net income (44 093 LKR/year for an average craft owner) than the

Table 6. Average annual net income of 3.5-ton craft owners in some of the centres sampled, Sri Lanka, 1980.

Centre	Number	Type of gear	Average annual net income (LKR)[a]
Barudelpola	6	Drift net	44343
Myliddy	8	Drift net	53156
Mattakotuwella	18	Drift net	59446
Kawawella	17	Drift net	70500
Mirissa	14	Drift net	72891
Pitipana	14	Drift net and longline	96302
Chilaw	14	Prawn trawl	65679
Alutwatta	12	Prawn trawl	92902

Source: Marga Institute (1980a).
[a]15.63 rupees (LKR) = US$1.

Table 7. Annual income (LKR)[a] for various occupations at selected locations, Sri Lanka, 1980.

Occupation	Walgampaya	Kelaidiwal Wewa	Udayagiri	Palamunai	Paranagama	Average
Owner-cultivator and sharecropper	1512	4428	8688	5640	2184	4452
Office worker	4776	6000	4356	5400	6856	5480
State employee	5880	8064	5328	8028	5880	6636
Minor grades (e.g., driver)	4728	5784	7200	4596	–	5580

Source: Marga Institute (1980b).
[a]15.63 ruppees (LKR) = US$1.

brackish water fishery (13 140 LKR/year) and the inland fisheries provided the lowest income (8799 LKR/year).

Within the same fishery (marine) and with the same type of craft and gear (3.5-ton craft), net income varies with the geographic location of the area fished (Table 6), presumably reflecting the abundance, composition, and accessibility of the resource. The fact that there is a difference between the incomes derived from the fisheries in different parts of the country is known to fishermen and one would expect those from low-income fisheries would migrate to fisheries from which larger incomes could be derived. This reaction, although natural, has not been particularly evident, possibly because fishermen are unwilling to be separated from their families or because of the difficulties of fitting into the social and economic conditions of a new community. Equally, the fishing communities in more affluent areas may prevent such migration of fishermen to their villages.

The per-person income of a fishing household in comparison with the national average gives an idea of the relative standards of living of fishermen. The per-person income of a fishing household was found to be 5498 LKR (US$353) compared to 3378 LKR (US$217), the income of the average Sri Lankan in 1979. Thus, the Sri Lankan fisherman appears to be better off than the average Sri Lankan.

However, a more appropriate comparison would be between the incomes of fishermen and those of similar socioeconomic groups engaged in parallel trades and vocations. For this purpose, the following communities were selected as a cross-sectional representation of the nonfishing population in the country: Walgampaya, an up-country agricultural village; Kelaidiwal Wewa, a small dry-zone village; Pelamunai, a Muslim coastal village; Udayagiri, a new settlement scheme community; and Paranagama, a semiurbanized town. From the average annual income levels of the communities classified by type of occupation (Table 7), the income levels of the fishermen are clearly far above those of other members of the rural community. Even after allowing for discrepancies due to different methods of computation, the income level of crew members (5498 LKR) is much greater than that of owner-cultivators (4452 LKR) and about the same as that of office workers (5480 LKR). Movement of capital and labour from the agricultural to the higher income-generating fishery sector is constrained by fishing communities not allowing outsiders to beach fishing craft on, or anchor boats off, the shoreline of the fishing village. These physical and social barriers to entry operate to maintain the returns to labour and capital in the fishing industry well above their respective opportunity costs.

However, the conditions under which the fishermen derive their incomes are quite different from those of cultivators and state employees. Although other workers work regular hours and they are occupied throughout the year, fishermen work long and irregular hours and on a seasonal basis. Therefore, income in terms of return for an 8-hour man-day should be compared (Table 8). Once again, the same conclusion is reached: the income of fishermen is

Table 8. Average income per 8-hour man-day, Sri Lanka, 1980.

Type of labourer	Average income (LKR)[a]
Crew member	
3.5-ton mechanized boat	79
17.5-foot fibreglass boat with outboard motor	79
Traditional craft with outboard motor	65
Traditional craft (marine)	22
Skilled labour (carpenter, etc.)	45
Building sector labourer	30
Agricultural labourer	22

Source: Marga Institute (1980a).
[a]15.63 rupees (LKR) = US$1.

higher than that of the other rural workers. However, the conditons under which this income is earned are very trying and risky. Moreover, there are no regular hours of work for fishermen who are at sea during the night as often as they are during the day. At the same time, they do not have a very participatory social life and contact with people beyond the village is virtually nonexistent.

Closed fishing community

The ancient, and necessary, practice of communities of living close to the areas in which their vocation or trade was carried out appears to have continued with the fishermen who, even now, prefer to live on the sea coast or lagoon shore despite the vast advances in transport and housing that would enable them to live further inland and travel to the coast for their vocation. Fishing is not merely an occupation but also a way of life closely bound up with living by the sea and having the feeling of belonging to the fishing community and its subculture. Moreover, in addition to the need to protect the resource and ensure access to it, craft and gear, which cannot be easily transported inland, must be protected and, finally, members of any local fishing community must stick together to prevent outsiders from gaining access to an otherwise open-access resource. This continues despite the fact that essential amenities such as sanitation facilities, supply of potable water, and housing conditions are limited in comparison to the conditions under which the rest of the rural population live. By virtue of their enforced separation, apparently sought by themselves, fishermen appear to have developed a culture of their own, which from their point of view is attractive and refined, although from the point of view of outsiders is rough and unappealing.

There are other reasons for their living away from the general population. As statistics reveal, fishing is largely practiced by particular castes, the people of which have been historically, culturally, and politically marginal to the old feudal system of the island. Quite a few people of these castes, however, who have had the courage, enterprise, and capital to break away from their traditional and inherited vocation have moved out to participate in the life of the wider community with distinction and success. The rest continue to live the life of their forefathers although in relatively better conditions.

Another possible reason for this separation of the community might be its engagement in the taking of life (of fish), a practice that is considered one of the five basic wrongful acts in Buddhism (see Fernando et al., this volume, p. 205).

Fishermen's association and communication with the inland population is minimal and intermarriages between the two communities are practically nonexistent. There is little prospect of improving the prevailing pattern of interaction in the foreseeable future. This indicates immobility on the part of the fishermen, which means that if, in the long run, the earnings of fishermen fall below the opportunity costs of their labour (and capital), they are likely to continue earning less than their opportunity costs rather than move out into land-based unskilled employment. Of late, however, there have been some instances of youngsters from inland communities moving to the coastal areas in search of employment in the fishing industry; eventually they settle down in particular fishing communities where labour shortage prevails.

Nonfishing sources of income

Of the total fishing population surveyed, it was found that 94% of the households had no other sources of employment and income than fishing. Even for the remaining 6%, nonfishing sources of employment have contributed a relatively insignificant part of the family income. The reasons for this situation may be many and varied. Fishermen, as a rule, do not own land other than their house plot on which there is little room for farming or even for a home garden. A supplementary source of employment must fulfill certain specific conditions:

- It must be available without the need for continuous engagement by the fisherman to which he is unable to commit himself;
- It should also be located in the vicinity of the fishing village; and
- It must fit the educational level and skilled nature of his labour.

Moreover, with mechanization, most fishermen are employed throughout the year, and those who are unable to brave the sea during the monsoon usually migrate to other parts of the coast or to the inland tanks.[2] Hence, there may be little need for the fishermen to seek other sources of income.

[2]This migration follows an established pattern and is limited to certain areas. As such, it does not contradict the concept of a closed fishing community.

Of the few members of fishing households who were engaged in exploiting other sources of income, about 50% were mainly employed as labourers, clerks, or teachers; 28% were traders; and 15% were general labourers who worked as casual employees. That only 7% were involved in agriculture indicates the fishing community's meagre links with the agricultural sector. It is observed that marine fishermen hardly ever engage in agricultural activities whereas some resident inland fishermen do engage in agricultural work at least during the main agricultural season.

Our survey revealed that some fishermen of the western and northwestern coasts have yet another source of income, which is illegal: some smuggle in contraband such as "beedi leaves," a type of leaf used for smoking, from the neighbouring Indian subcontinent in return for nets and fishing gear smuggled out of Sri Lanka and sold in south India.

The tourist industry is also said to provide an additional source of income for fishing households in and near tourist resorts such as Negombo where fishermen hire out rooms to tourists and where members of the households work as tourist guides.

Expenditure and savings, assets and liabilities

The expenditure pattern of the fishery household is rather peculiar in that few make any savings: 60% of households save less than 10% of income (Table 9) and no fisherman interviewed seemed to save more than 25% of his earnings. This pattern may be due to the fact that fishermen's incomes are irregular and uneven. As a result, they tend to spend their sudden "fortunes" on consumer durable such as radios, sewing machines, etc. It has been observed that fishermen do not systematically plan for the future, but spend extravagantly on clothes and recreation and even on alcohol and gambling so that, unlike most underdeveloped sectors of the economy, the fisherman's consumption expenses include heavy expenditure on less necessary items. This is not necessary even though fishermen are not able to plan on a daily or monthly basis. There is no reason why they cannot plan on a yearly or seasonal basis: their income varies a lot from day to day, but not so much between fishing seasons or years. It may simply be that the traditional type of fisherman does not perceive his income this way. The modern fisherman, by contrast, could be guided to adopt a longer-term perspective of his income and expenditure patterns, and plan accordingly.

Table 9. Distribution of households (%) by expenditures in various categories, Sri Lanka, 1980.

% of total household income	Consumption	Investment: Fisheries	Investment: Nonfisheries	Savings and insurance
1–10	0	16	50	60
11–25	5	67	50	40
26–50	32	14	0	0
51–75	26	3	0	0
76–100	37	0	0	0

Source: Marga Institute (1980a).

Having spent most of his income on consumption, semidurable luxury goods, clothes, and entertainment, the fisherman often has to rely on credit facilities to undertake major repairs to his craft or replacements to his gear. Thus the fisherman is quite often in debt to fellow villagers, money lenders, or traders to whom he sells his fish: these debts are normally settled at the end of a profitable season. It is important, therefore, to note that it is the fisherman's behaviour and not his income that is responsible for his debts. This has important implications for the government's credit policy.

No fisherman reported spending more than 25% of his income to buy fixed assets outside the fishing industry (Table 9) and these assets were usually his house and related property. There is hardly any evidence that the average small-scale fisherman invests in agriculture or other industries although the tourist industry is known to attract investment from fishermen in fishing centres such as Negombo and Hikkaduwa; however, these were not studied by the research team. It was observed that 92% of the total value of nonfishing assets belonging to fishermen are immovable assets such as land and buildings.

A fisherman's investment in the industry is mostly financed by his earnings from the industry itself (Table 10). A larger proportion (73%) of the younger group (15–25 years) was

Table 10. Sources of investment capital (%) in the fishing industry, Sri Lanka, 1980.

Source	Frequency
Earnings	
Fishing activities	37
Other activities	10
Government	4
Bank	11
Cooperative society	2
Fish trader	17
Moneylender	11
Other	8

Source: Marga Institute (1980a).

Table 11. Reinvestors (%) by level of income, Sri Lanka, 1980.

Income level (1000 LKR)[a]	Reinvestors (%)
2–5	0
5–7.5	100
7.5–10	65
10–25	37
25–50	35
50–75	50
75–100	22
> 100	17

Source: Marga Institute (1980a).
[a]15.63 rupees (LKR) = US$1.

investing in the fishing industry than of all other age groups combined (62%).

The numerous subsidy and insurance schemes, along with the credit facilities that include low-interest loans from the government, have had their impact on the industry: those who have achieved success in the industry have begun reinvesting their profits into the industry. The pattern of investments by these successful craft owners or fishermen presents a rather interesting picture (Table 11): low-income groups reinvest whatever savings they can harness in the industry itself, but the high-income group moves gradually away from the fishing industry by investing their earnings in nonfishing ventures.

This reluctance of the more affluent fishermen to remain in the industry may be motivated by their desire to move out of an apparently "sinful" and socially "nonrespectable" vocation and elevate themselves in the social ladder. In a country where Buddhists are in a majority, the minority groups such as Catholics, Hindus, and Muslims tend to adjust their ways of thinking to the majority's concepts and value judgments. Thus, non-Buddhist investors also move away from an industry that is considered "sinful" and nonrespectable.

This pattern of economic behaviour ensures that the Sri Lankan fishery remains at the level of small-scale operations. It also promises to prevent both the precipitous dualism common in other fisheries with all its accompanying problems (see Panayotou 1980a, for the case of Thailand) and also the overcapitalization of the industry leading to overexploitation of the resource base that characterizes the fisheries around the world. In the context of a limited resource base that can be biologically depleted through bad economic management, the movement of the better-off fishermen into other activities permits the less well-off to get a share of the resource rents and move up the ladder.

Policy Implications

High levels of profitability were recorded for every type of mechanized fishing operation. Mechanized fishing boats and outboard engines for traditional craft are sold to fishermen with subsidies of 35% and 50% of their costs respectively, and the remaining cost is financed by a bank credit scheme with convenient collateral requirement. The policy question that arises is whether it is legitimate for the government to subsidize producers who enjoy high levels of net income and profit and, if it is not, whether the subsidy could be withdrawn. In such a situation, the government could confine itself to providing infrastructural facilities, which are considered to be social investments, and to guaranteeing the bank credit scheme operated through the state banks for the modernization of fishing craft.

When considered on a daily basis, fishermen's incomes are variable and irregular but, when income is perceived on a yearly or seasonal basis, a regularity of income can be seen. The commonly held perception of the fisherman as one who is unable to plan expenditures on a systematic basis and tends to spend extravagantly on gambling, alcohol, and conspicuous consumption may be attributed to his failure to perceive his earnings in a long-term perspective. Savings that could be mobilized for productive purposes if income patterns are perceived within a long-term perspective tend to be dissipated by being utilized in an unplanned manner. Policy should be directed at educating fishermen to perceive their incomes within a long-term perspective and at evolving a system of budgeting for fishermen whose incomes are unpredictable in the short run but patterned predictably in the long run. Meaningful and realistic savings schemes for fishermen could be conceived and implemented to encourage increased savings.

Recently, the savings of fishermen have been increasingly directed toward investment in tourism as there is little opportunity in the environment of a coastal fishing village for investments other than in the fishing industry. Fishermen often provide guest-house facilities for low-budget foreign tourists in a country where beaches provide the main attraction for foreign tourists. The modern fisherman who is emerging through this process is likely to be partly a fisherman, partly a tourist guest-house owner, using his boat partly for catching fish and partly for servicing the tourist industry. Policy could aim at directing a part of fishery savings into an appropriate sector of the tourist industry — a scheme that can be worked out jointly by the ministries of Fisheries and Tourism. Various supportive services for such a scheme can be provided by the Tourist Board, while the two ministries can formulate a program through which fishermen's savings are directed partly to the fishing industry and partly to the tourist industry.

In the past, the fisherman's striving for subsistence left him little time to spend in the community. Now that income levels have risen well above the subsistence level, it is important to try and develop a type of community life for the fisherman in which he has access to a variety of social amenities and community services that will improve the quality of life in the fishing village. Housing has improved with higher incomes and the acquisition of consumer durables has increased. Policy should be directed toward providing the services necessary to improve the "quality" of life, now that income levels are high. The evidence of heavy expenditure on gambling and alcohol accompanying the rising levels of income indicates the absence of more meaningful cultural and recreational amenities suitable for a fishing village.

Women's time in a fishing community is underutilized, especially in Buddhist fishing villages. Formerly women were employed in cottage industries, such as lace making, as well as in the manufacture of rope from coconut fibre. The cottage industries declined with the availability of cheap factory-produced substitutes; the rope industry also declined with the fall in demand for rope in fishing villages resulting from the decline of the beach seine fishery. Policy can be directed toward organizing cottage industries in which women could be employed to produce various products for the tourist market in the coastal sector. Women may also be employed in fish by-product industries that could be set up in fishing villages. These should be industries that do not demand heavy investment in expensive machinery and equipment and that do not involve sophisticated technology and expertise. They could be satellites of the fishing industry so that the parent industry supplies the raw material for use in the new ventures. For example, before the dispatch of fish to distributing centres and markets, the fish could be cleaned, extracting and separating the offal (gill, guts, and fin), which could then be used in the preparation of fish meal and fish-feed for potential fish farmers.

Fishermen in Natural Depressions of Bangladesh: Socioeconomic Conditions and Standards of Living

Mahfuzul Huq and Ataul Huq

Recently, several policy guidelines and development programs for the fishing industry and for fishing communities have been formulated in Bangladesh. Those "behind the net" have, however, benefited only marginally, if at all, from such programs. A major reason for this is the lack of data on socioeconomic and institutional conditions pertaining to the life and work of the fishermen whom these programs are supposed to help. In the absence of such data, planners are working without a firm base and hence the development schemes to improve the lot of the fishermen are likely to fail altogether or only benefit the privileged few at the expense of the rest.

Apart from these general considerations, the study of the socioeconomic conditions of fishermen in natural depressions is of special importance on several other grounds. The natural depressions (also known as freshwater impoundments), which include oxbow lakes, defunct streams, low-lying farm lands, and marshy areas known as *haors, boars,* and *beels,* account for 20% of all inland fishing grounds. In area, they rank second in importance after rivers among the five important classes of inland water. The total area of 1.47 million ha of inland fishing grounds is distributed as: rivers, streams, and canals, 56.3%; natural depressions, 20.0%; brackish water, 12.4%; ponds and tanks, 5.2%; and lakes, 6.1% (Chittagong University 1977). In addition to these water bodies, there are 2.83 million ha of paddy fields that remain under water for 4–6 months each year. However, because this is only a seasonal water area and no particular fishing class could be identified with this water body, it was not considered here. The paddy fields produce 238 000 tons of fish and are the largest source of fresh-water fish. Natural depressions account for around 26% of all catches from inland water bodies. Although quite a number of studies on the socioeconomic conditions of fishermen in the river and pond sectors have been undertaken in recent years, similar aspects of fishing in freshwater impoundments are still virtually unexplored in this country. The fishing communities on these water bodies evoke special interest because of their unusual organizational setup. It is commonly believed that the majority of these fishermen are exploited by the few well-to-do investors who are, at the same time, fish traders and "waterlords."

Unlike the fishing grounds in some neighbouring countries of Southeast Asia (Cheng et al. 1977; Panayotou et al. 1980), fisheries in Bangladesh, especially those of freshwater natural depressions, are located in the vicinity of consumer centres, thus obviating the necessity of expensive methods of preservation, transport, and marketing operation (Chittagong University 1977). Unlike marine fisheries, the natural-depression fishery does not require costly fishing inputs such as mechanized craft, expensive gear, and exploratory gadgets to locate fishing grounds. For this reason, it has been chosen for further development in the Second 5-Year Development Plan in an attempt to bridge the wide gap between protein availability (8 g/day per person) and minimum protein requirement of 25 g/day per person (Bangladesh, Planning Commission 1980). The production of fish, the country's main source of animal protein, has gradually declined over the years for all inland water bodies. In the natural depressions, this is probably due to overfishing and the use of poisonous chemicals in rice production. This suggests the need for a study of the pros and cons of rice versus fish production strategies to recommend policy measures for maintaining a balance between the interests of the fishermen and fish consumers on the one hand and rice producers and consumers on the other.

Scope of Study

Although these are important issues in *haor* fishing that call for analysis, the lack of sufficient and reliable data has limited the scope of the present study to an attempt to enlarge the data base and gain an insight into the socioeconomic conditions of *haor* fishermen both vis-à-vis each other and by comparison to other occupational groups.

To obtain bench-mark information about the socioeconomic conditions and standards of living of the fishermen in the natural depressions of Bangladesh, we undertook a survey in three such fishing regions of the country to determine:

- Sociodemographic characteristics such as age structure, sex, marital status, family size, religion, and education;
- Occupational characteristics, classified into fishing and nonfishing, of household heads and other members;
- Pattern of employment for household heads and other family members; and
- Assets, income, and their determinants, such as fishing and nonfishing assets, fishing and nonfishing employment, locational and marketing advantages, composition of catch, opportunities for nonfishing employment, etc.

We have also attempted a statistical analysis of the factors bearing on fishing and total income of fishermen in different communities. In the process, we developed and tested certain hypotheses relating to the above parameters. We further delved into the issues of standard of living as demonstrated by income, expenditure, and savings. In this connection, the distribution of income and assets was also studied. Finally, based on our findings some tentative policy implications were derived.

Institutional Setup

After the abolition of the feudal system that had operated in colonial days, all the water bodies, including the *haors*, came under the control of the government. These water bodies are usually put on auction in segments for a period of 1 year. Although, in principle, only the fishermen's cooperatives were entitled to lease the *haor* fisheries, some malpractices in the past have contributed to the perpetuation of the nonfishermen's fishing right in these water bodies either through dummy cooperatives or through fish merchants and capitalists lending capital to the actual fishermen's cooperatives to win the bid. In addition, some *haors* are still privately owned as *khas* land.[1] These private waterlords-cum-lenders and fish merchants have mostly benefited from the *haors* by virtue of their link with the power structure. Because of the very temporary nature of the existing tenurial arrangement, the lessees always try to maximize their own catch by using nets with very fine mesh or even using destructive fishing gears, thus damaging the productivity of the stocks.

Sociodemographic Profile

The unit of analysis was the head of the household who, with only a few exceptions, was an adult male. No woman was found to be participating in fishing operations (Table 1). Of the household heads, 92% were married as against 81% for the nation as a whole. About 50% of them had had some formal education although there was some regional variation. We found differences in occupational mobility between the older generation, who cling to their ancestral profession, and the more adventurous youths, who feel no professional commitment to fishing. There appear to exist interesting relationships between religion, literacy, income, and standard of living. The Hindus in our study are more literate, have higher income, and a better standard of living: this is particularly true for Hindu Kuliarchar as compared with Muslim Habiganj and mixed Ajmiriganj: this observation agrees with the situation at the national level. All our study areas have family size larger than the national average size with almost equal dependency ratios (Table 1).

Employment structure

Nonfishing employment was limited to farming, trade, and wage labour in all the three areas studied because the areas, being distant and almost disconnected from the important urban and industrial centres and deficient in local natural resources, have little scope for industrial employment, natural-resource extraction activities, or petty employment.

Among the nonfishing occupations in the total sample, farming was most important (particularly at Ajmiriganj where land is relatively available) followed by wage employment for household heads and farming with trade for other members (Table 2). Because wage employment in these areas usually refers mainly to farm

[1] *Khas* land is a piece of land that is not rented out but is tilled or otherwise used by the landlord himself: hence, the ownership right is legally secure.

Table 1. Sociodemographic profile of heads of fishing households in three haor *villages, Bangladesh, 1980.*

Sociodemographic characteristics	Habiganj	Kuliarchar	Ajmiriganj	Total
Sample size	75	75	75	225
Sex (%)				
Male	100	100	100	100
Female	0	0	0	0
Age structure (%)				
Below 20	0	4	0	2
21–35	35	41	29	35
36–50	49	35	43	42
Over 50	16	20	28	21
Marital status (%)				
Married	92	87	96	91
Single	8	8	1	6
Widow(er)	0	5	3	3
Religion (%)				
Muslim	84	0	44	43
Hindu	16	100	56	57
Education (%)				
Illiterate	53	44	56	51
Class I–IV	27	31	24	27
Class V–VII	16	12	19	16
Over class VII	4	13	1	6
Average family size (number)	5.9	6.9	6.6	6.5
Working members per household	2.2	2.2	1.9	2.0

Table 2. Average monthly employment per household (man-days) in three haor *villages, Bangladesh, 1980.*

Type of employment	Habiganj				Kuliarchar				Ajmiriganj			
	Head	Other members	Total	% of total	Head	Other members	Total	% of total	Head	Other members	Total	% of total
Fishing	**17.8**	**16.3**	**34.1**	**84.8**	**20.2**	**21.0**	**41.2**	**85.3**	**18.2**	**18.7**	**36.9**	**76.5**
Own fishing	17.2	15.8	33.0	82.1	19.2	20.1	39.3	81.4	17.8	18.7	36.5	75.7
Fishing labour	0.6	0.5	1.1	2.7	1.0	0.9	1.9	3.9	0.4	0.0	0.4	0.8
Nonfishing	**2.8**	**3.3**	**6.1**	**15.2**	**2.9**	**4.2**	**7.1**	**14.7**	**6.0**	**5.3**	**11.3**	**23.5**
Farming	0.8	0.7	1.5	3.7	0.7	0.7	1.4	2.9	3.6	3.3	6.9	14.3
Hired labour	1.5	1.1	2.6	6.5	0.1	0.4	0.5	1.0	1.4	1.0	2.4	5.0
Trade	0.5	1.5	2.0	5.0	2.1	3.1	5.2	10.8	1.0	1.0	2.0	4.2
Total	**20.6**	**19.6**	**40.2**	**100.0**	**23.1**	**25.2**	**48.3**	**100.0**	**24.2**	**24.0**	**48.2**	**100.0**

wage employment, due to limited scope for nonfarm activities, farming and wage employment together accounted for an overwhelming proportion of nonfishing occupations for heads (80%) and for other household members (60%). This is true for the total sample as well as for individual locations except for Kuliarchar, which had a higher share of retail trade, possibly because of its trade-minded Hindu population and the opportunities for commercial activities due to the presence of an important train station.

Although retail trade was rather unimportant for the household heads in the total sample, it had some importance for other family members and was extremely important in Kuliarchar (Table 2).

Contrary to common belief, fishermen were found to be at least as fully employed as the nonfishing labour force, where full employment is taken to be 275 man-days/person per year (22.9 per month). Household heads in Ajmiriganj were found to work 24.2 man-days/month, those in Kuliarchar 23.1 man-days, and those in Habiganj 20.6 man-days. Thus, compared to the agricultural labour force of Bangladesh, the fishermen in all our study areas are definitely "overworked."

Income Levels

Household income is classified according to source in the same categories as employment, that is, fishing and nonfishing. Fishing income is, in turn, classified as income from own fishing and income from fishing labour and nonfishing income is classified as income from farming, hired labour, trade, and "other."

Fishing income accounted for over 80% of total household income in Habiganj and Kuliarchar (Table 3), corresponding closely to the contribution of fishing to total household employment (Table 2). This suggests that the remuneration per man-day of fishing and of nonfishing employment was about equal (Table 4). In contrast, fishing in Ajmiriganj contributed only 66% of total household income although it accounted for 77% of total employment: fishing, which paid less than 17 BDT/man-day (15.5 takas [BDT] = US$1) was less lucrative than nonfishing employment, which paid 28 BDT/ man-day. The reason that more people do not take up nonfishing employment, which pays better, and so equalize the return between fishing and nonfishing activities in Ajmiriganj appears to lie in the difference in the types of nonfishing employment among the three loca-

Table 3. Average monthly net cash income (BDT)[a] of households by source for three haor *villages, Bangladesh, 1980.*

Source of income	Habiganj Head	Habiganj Other members	Habiganj Total	Habiganj % of total	Kuliarchar Head	Kuliarchar Other members	Kuliarchar Total	Kuliarchar % of total	Ajmiriganj Head	Ajmiriganj Other members	Ajmiriganj Total	Ajmiriganj % of total
Fishing	**637**	**529**	**1166**	**82.8**	**945**	**1079**	**2024**	**83.8**	**329**	**289**	**618**	**66.0**
Own fishing	625	515	1140	80.9	928	1067	1995	82.6	321	289	610	65.1
Fishing labour	12	14	26	1.0	17	12	29	1.2	8	0	8	0.9
Nonfishing[b]	**33**	**61**	**243**	**17.2**	**80**	**111**	**390**	**16.2**	**57**	**44**	**319**	**34.0**
Farming[c]	–	–	134	9.5	–	–	168	7.0	–	–	203	21.7
Hired labour	21	23	44	3.1	2	5	7	0.3	27	24	51	5.4
Trade[d]	12	38	50	3.5	78	106	184	7.6	30	20	50	5.3
Other[e]	–	–	15	1.1	–	–	31	1.3	–	–	15	1.6
Total	**670**	**590**	**1409**	**100.0**	**1025**	**1190**	**2414**	**100.0**	**386**	**333**	**937**	**100.0**

[a]15.15 takas (BDT) = US$1.
[b]Because farming activities undertaken by the head of household could not be isolated from these done by other members, farm incomes appear in "household total" column only.
[c]Income from farming includes income from operated farm as well as that from land rented out and mortgaged out.
[d]Includes returns from retail trades, drying of fish, etc.
[e]Includes donations and gifts from friends and relatives.

Table 4. Average net cash income (BDT)[a] per man-day of employment in three haor *villages, Bangladesh, 1980.*

Source of income	Habiganj Head	Habiganj Other members	Habiganj Household total	Kuliarchar Head	Kuliarchar Other members	Kuliarchar Household total	Ajmiriganj Head	Ajmiriganj Other members	Ajmiriganj Household total
Fishing	**35.2**	**32.5**	**34.2**	**46.8**	**51.4**	**49.1**	**18.1**	**15.5**	**16.7**
Own fishing	36.3	32.6	34.5	48.3	53.1	50.8	18.0	15.5	16.7
Fishing labour	20.0	28.0	23.6	17.0	13.3	15.3	20.0	0.0	20.0
Nonfishing[b]	**16.5**	**23.5**	**38.8**	**36.4**	**31.7**	**54.9**	**22.0**	**23.9**	**28.2**
Operated farm	–	–	89.3	–	–	120.0	–	–	29.4
Hired labour	14.0	20.9	16.9	20.0	12.5	14.0	19.3	24.0	21.2
Trade	24.0	25.3	25.0	37.1	34.2	35.4	30.0	20.0	25.0
Total average[b]	**33.8**	**31.2**	**35.0**	**45.8**	**46.8**	**50.0**	**18.7**	**15.3**	**19.4**

[a]15.15 takas (BDT) = US$1.
[b]Because farm income could not be separated into that accruing to the household head and that accruing to other members of the household, farm income per man-day is computed under the "household total" column and farm time is not included in the time used to compute income per man-day for the head of household or other members.

tions. In Kuliarchar and Habiganj, the most important types of nonfishing employment are, respectively, trade and hired labour, into which entry is relatively easy; in Ajmiriganj, however, farming is the most common nonfishing employment and this requires ownership or rent of land.

Among the three locations, Kuliarchar had the highest total household income, over 2400 BDT/month, compared to 1400 BDT/month in Habiganj and barely 940 in Ajmiriganj (Table 3); that is, household income in the first two locations was between 1.5 and 2.5 times higher than in the third location. What accounts for this striking difference in incomes? Certainly not the number of man-days worked: Ajmiriganj households supplied as much labour as Kuliarchar households and 20% more than Habiganj households. The answer, rather, lies in the considerable differences in rates of remuneration among the three locations. Ajmiriganj households earned, on the average, only 19 BDT/man-day worked compared to 35 BDT in Habiganj and 50 BDT in Kuliarchar (Table 4). One might say that we observe something of a forward bending "supply curve" for labour, in the sense that low and high rates of remuneration correspond to higher amounts of labour supplied than intermediate rates — however, more observations are necessary to substantiate such a relationship.

In all three locations, farming was the most profitable activity, in terms of income per man-day, whereas hired labour whether in fishing or nonfishing activities was the lowest-paying occupation. The contribution of hired fishing labour to total household income was rather insignificant, accounting for less than 2% in all three locations. Trade's contribution was particularly important in Kuliarchar, where, as we mentioned earlier, there is an important train station.

Explaining income differentials

In this section, we attempt to explain why different households enjoy different levels of income; that is, we try to identify the determinants (or limiting factors) of income.

We postulated first a log-linear relationship between fishing income (dependent variable, Y) and fishing employment and fishing assets (independent variables, X_1 and X_2); fishermen's experience as measured by age was also included as an explanatory or independent variable (X_3). The parameters of this relationship were estimated from our survey data, using standard regression techniques (Table 5).

Our model explains between 39 and 57% of the variation in fishing incomes among fishermen. In all locations, fishing assets were statistically significant in explaining income levels. Fishing employment was significant in the case of Ajmiriganj and Habiganj but not in Kuliarchar. Fishing experience as measured by fishermen's age had no explanatory power, perhaps because older fishermen, although more experienced, are likely to be weaker and less innovative.

Because a large part of the income differentials remained unexplained, we postulated a second relationship, between total household income from all sources (Y) and five variables: fishing and nonfishing assets (X_4 and X_1), fishing and nonfishing employment (X_5 and X_2), and land ownership (X_3). We estimated this relationship both for individual locations and for all locations combined. In the latter case, a dummy variable (D) representing location-related characteristics was also included: because Kuliarchar is an important train station and better linked with the capital city, it was given the value of 1 whereas the other two sites, Ajmiriganj and Habiganj, which lack this advantage, were given the value of 0. This postulated income function was estimated using

Table 5. Relationship between fishing incomes and factors of production in three fishing villages, Bangladesh, 1980.[a]

Y	Constant	X_1	X_2	X_3	R^2	*F* ratio	Sample size
Ajmiriganj	4.9	0.47*a* (5.5)	0.13*a* (2.85)	0.01 (0.13)	0.57	29.6	70
Kuliarchar	3.26	0.16*c* (1.35)	0.39*a* (6.78)	−0.12 (−0.77)	0.48	18.11	61
Habiganj	1.00	0.81*a* (5.11)	0.12*b* (2.17)	0.07 (0.45)	0.39	14.82	73

[a]Y stands for fishing income, X_1 for fishing employment (man-days), X_2 for fishing assets (BDT), and X_3 for experience (age): *a*, *b*, and *c* are levels of significance, 1, 5, and 10% respectively; and values in parentheses are *t* statistics.

our survey data and ordinary least-squares regression (Table 6).

When all sites were taken together, our model explains over 50% of the overall variation in income among the sampled households. Differences among fishermen in the ownership of both fishing and nonfishing assets and in fishing employment were statistically significant (at the 1% level) in explaining differences in income. Equally significant was the difference in location indicating that Kuliarchar with its train station indeed held an advantage over the other locations. These results were in line with our expectations. What is somewhat surprising is that land ownership was statistically insignificant, suggesting that land ownership and income were unrelated even in a country of severe land scarcity. However, this result could be explained by the uneconomic size of the plots and by institutional constraints, such as insecurity of tenure and multiple ownership, which hamper the proper utilization of land. Fishing employment and ownership of nonfishing assets (excluding land) appear to be the most important determinants of household income when all sites are considered together.

When income functions were estimated separately for each site, fishing employment was again the most important determinant of income, particularly in the cases Ajmiriganj and Habiganj, which lack the nonfishing opportunities of Kuliarchar. Fishing employment at the latter was not statistically significant, but nonfishing employment was ($P = 0.01$). Fishing assets could explain a substantial part of the variation in Kuliarchar and Habiganj ($P = 0.01$) but not in Ajmiriganj where nonfishing employment was highly significant as it was in the case of Kuliarchar. Nonfishing assets and land ownership played no significant role except in the case of Habiganj where the effect of land ownership on income was negative, perhaps due to locational and occupational immobility related to land ownership.

Although, in all cases, we were able to explain over 50% of the variation in income (almost 70% in the case of Kuliarchar), a substantial part of the variation remains unexplained so that additional research is needed on this topic. From our preliminary findings, however, we may tentatively conclude that land ownership was not an important determinant of income in any location. The significant determinants of income varied from location to location: in Ajmiriganj, it was fishing and nonfishing employment; in Kuliarchar, it was fishing assets and nonfishing employment; and, in Habiganj, it was fishing and nonfishing assets.

Expenditure, Savings, and Indebtedness

The ratio of expenditure on food to total expenditure, known as the Engel's coefficient, and the rate of saving (including purchase of consumer durables) are indicators of standard of living. The higher the Engel's coefficient and the lower the rate of saving, the lower is a household's standard of living. Households in Ajmiriganj, which were found to be the poorest in terms of income (Table 3), spent 76% of their total consumption expenditure on food (Table 7). The Engel's coefficient for the middle-income Habiganj was 74% and for the high-income Kuliarchar 68%. The corresponding saving rates were -15, 30, and 31% respectively. The last two values are surprising when compared to the national average saving rate of 4% in the late 1970s (see Bangladesh, Planning Commission 1980, table 1.4).

Table 6. Relationship between total incomes and factors of production in three fishing villages, Bangladesh, 1980.[a]

Y	Constant	X_1	X_2	X_3	X_4	X_5	D	R^2	*F* ratio	Sample size
All locations	3.79	0.21*a*	0.11*c*	-0.05	0.12*a*	0.36*a*	0.26*a*	0.53	26.4	143
		(2.99)	(1.92)	(-0.87)	(2.62)	(3.97)	(2.07)			
Ajmiriganj	4.94	0.12	0.19*a*	0.06	-0.02	0.41*a*	–	0.58	15.3	61
		(1.41)	(2.62)	(1.09)	(-0.39)	(4.60)				
Kuliarchar	5.67	0.01	0.21*a*	0.14	0.19*a*	0.29*c*	–	0.69	16.7	43
		(0.07)	(2.44)	(1.51)	(3.13)	(1.76)				
Habiganj	1.66	0.36*a*	0.60	-0.26*b*	-0.23*a*	0.38*b*	–	0.57	8.7	39
		(2.75)	(0.57)	(-2.04)	(2.86)	(2.12)				

[a]Y stands for total income, X_1 for nonfishing assets (BDT), X_2 for nonfishing employment (man-days); X_3 for land property; X_4 for fishing assets (BDT); X_5 for fishing employment (man-days); and D for dummy variable representing locational and marketing advantage; *a*, *b*, and *c* are levels of significance, 1, 5, and 10% respectively; and values in parentheses are *t* statistics.

Table 7. Engel's coefficients and savings/dissavings rates in three fishing villages, Bangladesh, 1980.

	Per capita income (BDT/month)[a]							
	0–49	50–99	100–149	150–199	200–299	300–399	Over 399	All groups
Engel's coefficient[b]								
Habiganj	–	78.5	78.1	78.3	76.7	67.4	62.2	73.6
Kuliarchar	–	79.9	72.9	75.9	77.9	59.2	59.9	67.9
Ajmiriganj	74.7	76.9	72.9	76.8	79.1	54.8	–	76.3
Savings rate[c]								
Habiganj	–	-60.6	-0.8	6.0	27.5	41.0	57.5	29.7
Kuliarchar	–	-44.5	-37.7	-7.5	19.0	16.2	48.7	30.5
Ajmiriganj	-62.6	-89.6	-12.0	-6.9	9.8	38.5	–	-15.2

[a]15.15 takas (BDT) = US$1.
[b]Expenditure on food as a percentage of total expenditures (see Table 8).
[c]Savings as a percentage of total household income (see Table 8).

We can obtain additional insight into standards of living by studying expenditure and savings by income group. The Engel's coefficients exhibit the expected pattern for large income differentials: they are well above 70% for groups with incomes less than 300 BDT/person and well under 70% for those with incomes over 300 BDT (Table 7). Virtually all groups with incomes less than 200 BDT/person are net "dissavers" and those with over 200 BDT are net savers. Among the dissaving groups are 54% of the Ajmiriganj households, 32% of the Kuliarchar households, and 21% of the Habiganj households. Dissaving rates range between 1 and 90% and saving rates between 6 and 58% of total household income.

How were the savings by high income fishing households being utilized? It was observed that the "richest" fishermen in Habiganj invested a substantial proportion of their savings in such nonfishing sectors as construction of luxurious dwellings, speculative investment in land in urban areas, social festivities, and conspicuous consumption. Whatever investment they make in fishing is in the form of leasing more areas of *haor* water bodies and not for the improvement of the existing fisheries. Unfortunately, we were not able to obtain complete information on the use of savings in the other two sites. Nor were we able to determine the sources of such large volumes of dissavings by the poorest households except to say that dissaving was financed by borrowing. However, borrowing cannot go on indefinitely. From a single year's data, we cannot surmise that dissavers are chronic dissavers but, if they are, eventually they must loose ownership of their assets which they put as collateral for borrowing, thereby losing both a source of income and their ability to borrow and hence falling into deeper poverty.

Our survey data indicate certain contrasting and yet interesting features about the nature and level of indebtedness. An average family of the poorest site, Ajmiriganj, having 33% less income than a Habiganj family borrows three times more than the latter. An average family of Kuliarchar, on the other hand, having two and a half times as much income as that of Ajmiriganj borrows almost the same amount. Whether this wide difference in the volume of loans is an indication of differences in financial needs for production or consumption is difficult to say from this aggregate analysis because there appears to be no clear relationship between the state of poverty or affluence and the volume of loan incurred. However, it is quite likely that the indebtedness in Ajmiriganj is for financing consumption, whereas in Kuliarchar as well as Habiganj it is for production. One thing at least is clear, noninstitutional loans, which are more common, are relatively cheaper in areas having better institutional lending facilities than in areas that lack them. For example, the rates of interest for such noninstitutional loans are 42 and 51% respectively for Habiganj and Kuliarchar — the areas with better banking facilities — as against 208% in Ajmiriganj, which lacks such institutional facilities. For institutional loans, the rate of interest is lowest in Ajmiriganj despite its paucity of banking facilities: possibly because the fishermen there borrow from the cooperatives organized by themselves and these are the only source of institutional loans available to them.

Standard of Living

Given the average size of family (5.9–6.9 persons), the data on monthly expenditure (Table 8) suggest that the standard of living —

Table 8. Monthly expenditures and savings in three fishing villages, Bangladesh, 1980.

	Per capita income (BDT/month)[a]							
	0-49	50-99	100-149	150-199	200-299	300-399	Over 300	All groups
Habiganj								
Total income	-	647	787	890	1352	1909	3666	1409
Expenditure								
Food	-	816	619	655	752	759	969	729
Nonfood	-	223	174	182	228	367	588	261
Total	-	1039	793	837	980	1126	1557	990
Savings	-	-392	-6	53	372	783	2109	419
Kuliarchar								
Total income	-	483	777	1125	1540	2175	6344	2414
Expenditure								
Food	-	558	634	918	972	1080	1948	1139
Nonfood	-	140	236	291	275	743	1305	539
Total	-	698	870	1209	1247	1823	3253	1678
Savings	-	-215	-93	-84	293	352	3091	736
Ajmiriganj								
Total income	270	471	691	1426	1250	2793	-	936
Expenditure								
Food	328	687	665	1171	892	942	-	822
Nonfood	111	206	247	354	235	777	-	256
Total	439	893	912	1525	1127	1719	-	1078
Savings	-169	-422	-221	-99	123	1074	-	-142

[a] 15.15 takas =US$1.

represented here by monthly household expenditure and assuming no price differential between locations — in Kuliarchar is 70% higher than in Habiganj and 55% higher than in Ajmiriganj.

That the nation as a whole and more particularly the small-scale fishermen have a very low standard of living is evident from the values of Engel's coefficients, which were between 68 and 76% for the three locations (Table 7). Although, the Engel's coefficients for Habiganj and Ajmiriganj are almost equal, the standard of living appears to be slightly better in the former. For Kuliarchar, the higher standard of living is evident from higher percentage, as well as absolute amount, of household expenditure on social goods such as education and medical care (6% in Kuliarchar against 2% in Habiganj and Ajmiriganj). This view is further strengthened by the lower percentage of expenditure on cereals in Kuliarchar than in Habiganj and Ajmiriganj (37% versus 44 and 49%). The expenditure on foods rich in protein is again relatively lower in Habiganj and Ajmiriganj than in Kuliarchar. The smaller percentage of expenditure on fuels suggests that, except for kerosene for lighting purposes, fuel is collected rather than purchased in all the areas, but no attempt was made to impute a value for it. If possession of consumer durables such as wooden furniture, refrigerators, television, radios, and musical instruments is taken as an indicator of above-subsistence standard of living then most of the fishermen in our study are just surviving.

Income and Asset Distribution

The previous discussion of the standard of living conceals intragroup differences within the fishing communities. This difference is due to the inequality in distribution of income and ownership of assets. These are shown in the form of Lorenz curves (Figs. 1 and 2).

Income (Fig. 1) was relatively more equally distributed than assets (Fig. 2) in all three areas studied. Moreover, the distribution of income was slightly more egalitarian in low-income Ajmiriganj than in the other two higher-income sites. The reverse was true for assets where Ajmiriganj had the most unequal distribution. There was no significant difference in asset distribution between the other two locations.

The magnitude of inequality in income and asset holding can be summarized in the Gini coefficients of inequality in which higher coefficient values indicate greater inequality in the distribution of income and assets. Distribution of income and assets for our study areas is

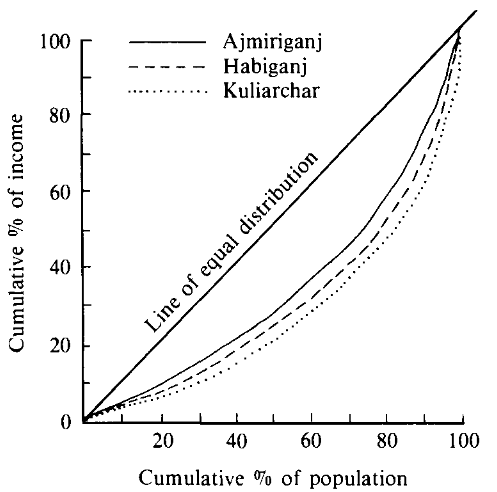

Fig. 1. *Lorenz curves for distribution of income per person in three fishing villages, Bangladesh, 1980.*

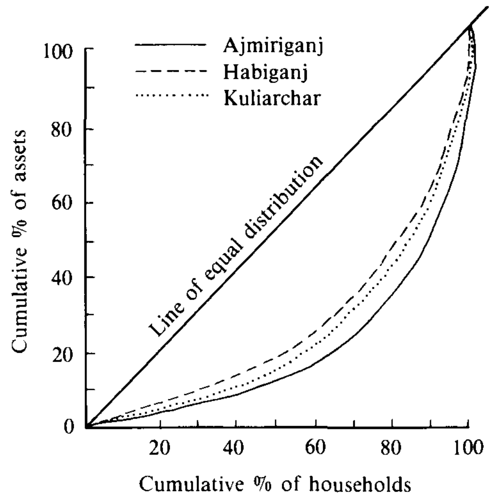

Fig. 2. *Lorenz curves for distribution of assets per household in three fishing villages, Bangladesh, 1980.*

apparently more egalitarian than for rural Bangladesh as a whole (Table 9). This is probably because the major part of income in our study areas is derived from a source, the *haor* water bodies, that is almost equally accessible to all the fishermen and income inequality is likely to be less than in other sectors where access is rather restricted (i.e., farming, trade, etc.). The reason for the relative inequality in asset holding is perhaps the inheritance of certain assets (e.g., land, boats, nets, etc.), which occurs to the fortunate ones alone.

Haor *Fishermen in Relation to the Rest of the Economy*

At this stage, it is only logical to inquire as to where the *haor* fishermen stand in relation to the population in the other sectors of the Bangladesh economy. Such comparison is constrained by the conceptual differences of the relevant parameters on the one hand and the nonavailability of comparable national data on various

Table 9. Gini coefficients of income and assets for three fishing villages, Bangladesh, 1980.

	Ajmiriganj	Habiganj	Kuliarchar	National[a]
Income	0.208	0.248	0.258	0.340
Assets	0.490[b]	0.400[b]	0.420[b]	–
Farm	–	–	–	0.510
Nonfarm	–	–	–	0.900

[a]See Khan et al. (1981).
[b]Includes both farm assets (land and property) and nonfarm assets (boats, nets, and other fishing gear).

counts on the other. Nonetheless, the broad picture that emerges from the limited data at our disposal is worthwhile.

In terms of family and household characteristics, there appears to be only a marginal difference in the family size. The *haor* fishermen in particular, and fishermen in general, have relatively larger families compared to the nation as a whole. This may be because fishing involves team work requiring a relatively large number of helping hands; however, the dependency ratios for the sample fishermen and for rural Bangladesh do not differ much. In contrast, there is a significant difference in the rate of literacy: the fishermen in general for all of our study areas have a higher rate of literacy than the nation as a whole but we could not determine the reason.

The fishermen in *haor* areas have, on the average, a higher monthly income than the rest of the rural population. This higher income is shown in higher consumption, especially of social goods, and a higher savings ratio particularly for the upper income groups. The relatively higher income in fisheries is possibly explained by higher participation ratio and more man-days of employment per person in this sector than in the rest of the economy, especially in the agricultural sector where farming, at least in the areas studied, was paying more per man-day than fishing. Fishermen are not better off than farmers: they are better off than rural dwellers of whom many are unemployed or underemployed. Moreover, the aggregate picture is misleading because of the unequal distribution of income within both fishing and farming communities:

the average household income in Ajmiriganj was only one-third that in Kuliarchar.

Regarding sources of loans and rates of interest, the fishing sector and particularly the *haor* fisheries seem not to diverge much from the rest of the economy. Like the agricultural sector, noninstitutional loans are more common among small or marginal fishermen whereas well-off fishermen get more institutional loans at a more favourable rate than from noninstitutional sources.

Policy Recommendations

In view of the complex socioeconomic relations of the *haor* fishing communities vis-à-vis the rest of the economy and the interactions of heterogeneous factors and institutions impinging on production, distribution and economic well-being, it is, indeed, difficult to prescribe any short-cut policy package to improve the level of welfare of *haor* fishing communities. Nevertheless, certain policy recommendations, most of which follow from the foregoing analysis, can be made.

The system of short-term leases of *haor* water to nonfishermen should be replaced by long-term leases, 3–10 years, given to actual fishermen to reduce the uncertainty of tenure and consequent destruction of the stocks. The present arrangement of open auction, which benefits mainly nonfishing merchant capitalists, should be abolished. In this respect, the guiding principle should not be the maximization of revenue but the ensuring of "tenurial justice" to the bona fide fishermen. Furthermore, the *haor* fisheries must be cleared of the bogus cooperatives, nonfishing intermediaries, and absentee waterlords: these were among the demands submitted to the government by *haor* fishermen in a recent convention held at Dhaka.

Overfishing leads to decline in stocks, which, in turn, encourages the use of destructive methods of fishing and finer fishing gears to maintain the level of catch. Unlike the case of the unexploited or little exploited marine water bodies, no policy should be adopted to help the *haor* fishermen to acquire improved fishing gears or encourage their use. Although, in the marine water bodies of Bangladesh, there is a vast scope for increased exploitation of fish resources (evident from frequent unauthorized fishing by private Thai and Burmese trawlers), in the natural-depression fisheries this is not the case. In the absence of definite measures for the automatic replacement of fish stocks in natural depressions, acquisition of technically more efficient gear and nets will contribute to a more rapid exhaustion of fish stocks. There is, rather, need for legislative measures to control the use of existing gear. Reclamation and reexcavation of the *haors* and pollution reduction through the control of the application of harmful chemicals in farming may be used as additional measures.

In recent years, many *haor* areas have been in use for the cultivation of high yielding varieties of rice or their irrigation during the winter: this disturbs the ecological balance of these water bodies. To prevent things from getting worse, a conscious and realistic production strategy toward the fish–rice balance should be formulated by considering the short- and long-term implications of any particular policy. Further study in this area is clearly needed.

Although the average *haor* fisherman earns more than the average rural dweller, fishing income per unit of effort (man-day) is lower than farming income. Yet, fishing for most people in the *haor* areas is their primary occupation. This is because of the increased landlessness of the *haor* population (as it is also the case elsewhere in the country) and the open-access nature of the fishing profession: the latter has led to the overcrowding of the *haor* fishing waters. The relatively high average income of *haor* fishermen as a group conceals the poverty of the marginal fishermen. To improve the socioeconomic conditions of the bottom 50% of the *haor* fishermen, it would be necessary to withdraw certain groups from *haor* fishing waters such as nonfishermen and large-scale fishermen, as well as some marginal fishermen. The withdrawal of the former groups requires legislation and enforcement by the government whereas that of the latter group calls for government assistance to move people to other sectors. In view of the slow rate of growth of the nonfishing sectors, the movement out of fishing may not come in the near future or automatically.

Production Technology and Efficiency

Production Technology and Economic Efficiency: A Conceptual Framework

Theodore Panayotou

Fishing income differentials may be attributed to differences in prices, catches, and technical and price efficiency. A study of production technology and efficiency takes prices as "given" and attempts to explain differences in incomes arising from differences in catch and price efficiency. Catch in turn may vary among fishermen due to differences in technology, input combination, fishery resource abundance, and technical efficiency, in addition to pure luck. Questions to which answers are sought here are:

- Why do fishermen operating in the same location catch different quantities of fish? Is it because of differences in the type and size of gear, boat tonnage, engine power, mesh size of net, time spent fishing, or because of varying degrees of inefficiency in the use of these inputs?
- What is the contribution of each fishing input to catch, and would a doubling of all inputs double catch?
- Are operating inputs such as fuel and labour used at their profit maximizing level?

In attempting to answer such questions, it is useful to formulate a production relationship relating fishing inputs to catch. Such a relationship is known as the "fishery production function."

Fishery Production Function

Models of fishery economics ideally include both a biological unit and an economic unit. In very basic models, the biological unit consists of a growth function relating natural growth (reproduction plus individual growth minus mortality) to the fish population size or fish stock. The best known such relationship is the logistic growth function:

$$G = G(X);\ G(X) \gtreqless 0 \text{ for } X \lesseqgtr K,\ dG/dX \gtreqless 0 \text{ for } X \lesseqgtr X_{MSY}$$
$$d^2G/dX^2 < 0 \text{ throughout.} \qquad [1]$$

Where G is natural growth measured in weight of biomass; X is fish stock also measured in weight of biomass; and K is natural equilibrium stock or carrying capacity of the environment.

Equation [1] may be depicted as the logistic growth curve (Fig. 1). Point X_{MSY} is the fish stock that gives rise to maximum growth and K is the equilibrium population toward which a fishery tends to move in the absence of fishing given food availability and other environmental parameters.

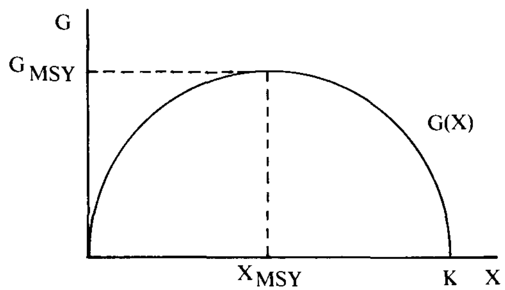

Fig. 1. Logistic growth curve.

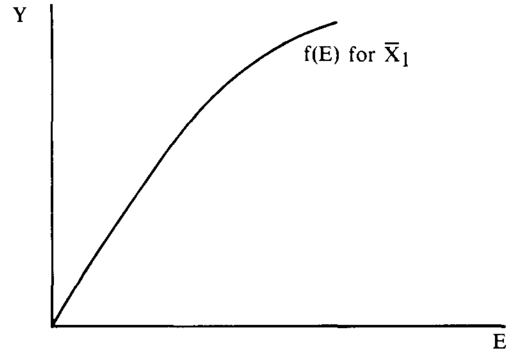

Fig. 2. Production function.

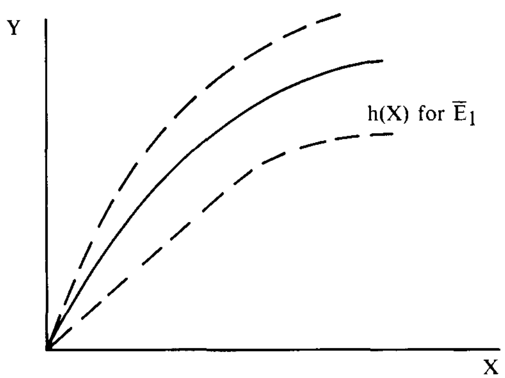

Fig. 3. Effort curve.

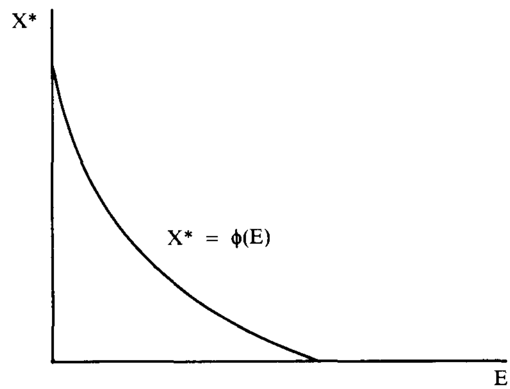

Fig. 4. Population equilibrium curve.

The economic unit consists of the relationship between output (catch) and inputs (fishing effort) known as the production function (Fig. 2):

$$Y = f(E); \partial f/\partial E > 0, \partial^2 f/\partial E^2 < 0 \text{ for } X = \bar{X} \quad [2]$$

This equation states that, for any given $\bar{X}$, the larger the effort (E), the greater is the catch (Y). Conversely, for any given $\bar{E}$, the larger the fish stock, the greater is the catch (Fig. 3):

$$Y = h(X); \partial h/\partial X > 0, \partial^2 h/\partial X^2 < 0 \text{ for } E = \bar{E} \quad [3]$$

The curve h(X) in Fig. 3 is known as the effort curve. Moving along this curve, E remains constant but changes in effort can be depicted as shifts of the curve. Thus, incorporating the production function of Fig. 2 into Fig. 3 would produce the dotted curves as effort varies.

If we now combine equations [2] and [3], we obtain the (long-run) fishery production function:

$$Y = F(E,X); \partial F/\partial E > 0, \partial F/\partial X > 0, \partial^2 F/\partial E^2 < 0, \partial^2 F/\partial X^2 < 0 \quad [4]$$

Combining equations [1] and [2] and setting Y = G, we obtain:

$$X^* = \phi(E); \partial \phi/\partial E < 0 \text{ and } \partial^2 \phi/\partial E^2 < 0 \quad [5]$$

Where X^* is the population equilibrium size, i.e., the fish stock corresponding to a catch that is equal to natural growth ($Y^* = G$). Equation [5] is depicted as the population equilibrium curve (PEC) of Fig. 4.

Substituting [5] into [4], we obtain the sustainable yield equation [6] or curve (Fig. 5):

$$Y^* = F[E, \phi(E)] = F^*(E) \quad [6]$$

Where Y^* is sustainable yield in the sense that $Y^* = \bar{G}$ and the corresponding fish stock remains unaffected by fishing (as long as $E = \bar{E}$).

The following properties hold for equation [6]:

$$dF^*/dE > 0 \quad \text{for} \quad 0 < E < E_{MSY} \quad [6a]$$

$$dF^*/dE = 0 \quad \text{for} \quad E = E_{MSY} \quad [6b]$$

$$dF^*/dE < 0 \quad \text{for} \quad E > E_{MSY} \quad [6c]$$

Property [6c] corresponds to the point of the maximum (long-run) catch or maximum sustainable yield (MSY) as it is known. Any point on $F^*(E)$ gives a sustainable yield, i.e., a catch that is equal to natural growth at the corresponding fish stock that is maintained unchanged as long as effort remains unchanged. Point A, however, is unique in the sense of maximizing natural growth and catch.

Although the size of the fish stock, or resource abundance, varies among fishing grounds and time periods, in the short run (for time-series analysis) or in a specific location (for cross-sectional analysis), the fish stock $(\bar{X})$ in the fishery production function [4] can be assumed to be constant ($X = \bar{X}$) and eliminated from the equation as an explanatory factor of variations in catch; i.e., we may estimate a production function of the form shown in equation [2]:

$$Y = f(E) \quad [2]$$

Fishing effort (E) is a composite input that can be broken down into its component elements: capital, labour, material, and time spent fishing. Capital, in turn, may be broken down into fishing boat, engine, and fishing gear. Each of these has one or more characteristics by which it could be represented: length and tonnage of boat, horsepower of engine, headrope length of gear, mesh-size of net, etc. Capital may be represented by the construction cost or estimated current value and be measured in monetary terms. All capital components plus labour determine a fishing unit's catching power, whereas the time spent fishing determines the rate of utilization of existing fishing capacity. Because of the use of a variety of fishing gears (and fishing methods), it may be necessary to classify fishing units by type of gear used: for instance, cast net, push net, trawl, purse seine, gill net, etc.

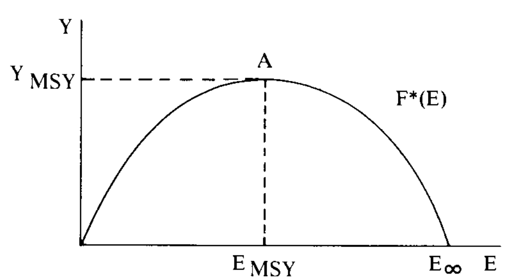

Fig. 5. Sustainable yield function.

In fact, the fishermen or fishing units produce not fish but effort (each fisherman's catch depends not only on his own effort but also on the effort applied on the given fish stock by fellow fishermen). Fishing-unit operators combine the inputs of capital (K), labour (L), and material (M) to produce catching power, which, when multiplied by time spent fishing, gives the amount of effort expended:

$$E = F(L,M,K)t = \Theta(E_i) \qquad [7]$$

Where i = 1, 2, . . ., n stands for different components of efforts, such as boat size (length or tonnage), engine power, mesh size, length of gear, labour, and fishing time.

Then equation [2′] may be rewritten as:

$$Y = f(E) = f[h(E_i)] \qquad [2'']$$

Considering the multispecies nature of tropical fisheries, an index of catch rather than catch in weight of biomass (Y) should be used as a dependent variable in equation [2″]:

$$Q = \Psi(E_i) \qquad [8]$$

Where Q is an output index based on the composition of catch using the corresponding prices as weights. (We assume that price differences among fishermen reflect differences in species and size composition of the catch rather than differential monopsonistic power of middlemen.)

Functional Specification and Analysis

For the purpose of empirical estimation, equation [8] may be given any one of several functional forms. For instance, it may be specified as:

$$lnQ = \sum_i b_i lnE_i \qquad [9]$$

known as the Cobb-Douglas function, or as:

$$lnQ = \sum_i b_i lnX_i + 0.5\sum_i \sum_j b_{ij} lnX_i lnX_j \qquad [10]$$

known as a *translog* production function, of which Cobb-Douglas is a special case ($b_{ij} = 0$ for all i s and j s).

Equations [9] and [10] — with appropriate error terms added to account for random variations — can be estimated using sample data (on catch and effort) and least-squares regression techniques. The estimated values of the parameters b_i supply the necessary information for the calculation of important measures such as the marginal products of fishing inputs, production and substitution elasticities, returns to scale, and the degree of technical and economic efficiency in input use. (A limitation of the Cobb-Douglas function is that it constrains the elasticity of substitution between inputs to be always equal to one.)

Consider, for example, the simpler case of the Cobb-Douglas. The marginal product of input i (MP_i), which gives the increase in catch contributed by one additional unit of input i, is given by:

$$MP_i = b_i(Q/E_i) \qquad [11]$$

A more meaningful measure of each input's contribution at the margin is its production, or catch, elasticity, defined as the percentage change in catch due to a 1% change in the quantity of the input used. In the case of Cobb-Douglas, the parameters b_i themselves are the production elasticities:

$$d\ln Q/d\ln E = (dQ/Q)/(dE_i/E_i) = a_i \qquad [12]$$

The estimation of a production function yields further useful results such as the returns to scale, which indicate the proportionate increase in output resulting from a proportionate increase of all inputs. If doubling of all inputs brings about a doubling of output, constant returns to scale are said to prevail or the production function is homogeneous of degree one. If output more (or less) than doubles as a result of a doubling of all inputs, we have increasing (or decreasing) returns to scale or the production function is homogeneous of degree greater (or less) than one. In a Cobb-Douglas production function, the returns to scale (RTS) are given by the sum of input coefficients:

$$RTS = \sum_i a_i \qquad [13]$$

Technical and Economic Efficiency

Because fishing technology is not homogeneous (standardized) but consists of different types of fishing gears and fishing methods, which cannot be quantitatively described, it would be necessary either to use dummy variables to capture qualitative difference in fishing technologies (types of gear) or to estimate one production function for each type of gear separately.

Similarly, because resource abundance differs from location to location and detailed stock assessment information is not readily available, we may account for resource availability either by using dummy variables to distinguish between locations or by estimating one production function for each location. Therefore it is possible to account for both different gear types and different resource availability either by estimating one production function per gear type per location or by estimating one aggregate production function with appropriate dummy variables to distinguish between gear types and locations. In the latter case, the technical efficiency of the various types of gear and fishing locations can be compared to that of a base gear and a base location (and hence against each other) by adding the coefficient on the corresponding dummy variable to the constant and comparing the resulting total intercepts. The higher the intercept, the further out the production function lies and hence the more output that can be produced from given amounts of inputs, i.e., the more efficient is the technology or the more abundant (accessible) is the fishery resource, or both.

As well as the differences in the use of fishing inputs and the differences in resource availability among locations and resource accessibility among different types of gear modeled through equations [9] and [10], differences among fishermen in managerial ability may also explain part of the variation in catch. Most fishermen acquired their knowledge of fishing techniques through experience on the job. Differences in managerial ability may arise from such factors as age, education, experience in fishing, sex, marital status, and religion. Younger fishermen may have less experience but they may be more willing to take risk; more educated fishermen may be better managers due to their ability to obtain promptly information on technological advances and market conditions; fishermen who have longer experience in fishing may have become more efficient through trial and error. Sex is also expected to affect management ability in fishing, a traditionally male-dominated occupation. The role of marital status and religion as determinants of management is not as clear: one cannot say a priori that a married person would be a better manager than a single person or that a Buddhist would differ from a Muslim in ability to manage. It is possible, however, that a married person would be more cautious and conservative in his decisions than a single person of the same age, education, etc. who tends to take more risk. There is also a widely held, but not rigorously tested, hypothesis that Muslims avoid long fishing journeys.

Management ability is also reflected in the economic efficiency with which inputs are being used. Economic efficiency dictates that the use of each input (i) is expanded to the point where the value of its marginal product (VMP_i) equals its unit cost (P_i):

$$VMP_i = P_i \qquad [14]$$

Where $VMP_i \equiv P(MP)$.

If VMP_i is greater than P_i, the amount of the input used is too low and must be increased; however, if VMP_i is less than P_i, the amount of the input is too high and should be reduced. This implies, for example, that additional fishing trips should be undertaken until a trip brings in a catch just covering the cost of the trip; fewer trips would leave some profitable opportunities unexploited and more trips would not cover their cost.

It is possible, however, that small-scale fishermen, who almost by definition face capital constraints, are not in a position to employ sufficient quantities of purchased inputs to drive their VMP down to their unit cost. In such a case, economic efficiency would mean equality between shortfalls in the use of the various inputs, i.e., $(VMP_i - P_i) = (VMP_j - P_j)$. If this equality does not hold, efficiency (and profits) can be increased by rearranging the limited budget between inputs, through better management, as well as by relaxing the capital constraint through better access to credit.

Production Technology and Economic Efficiency of the Thai Coastal Fishery

Ruangrai Tokrisna, Theodore Panayotou, and Kamphol Adulavidhaya

The socioeconomic and cost and earnings studies under the Kasetsart–International Development Research Centre (IDRC) Small-Scale Fisheries Project revealed significant differences in fishing incomes among coastal fishermen in Thailand. There were wide differences among fishermen operating the same type of gear in different locations as well as among fishermen operating different types of gear in the same location. Even fishermen operating the same type of gear in the same location had diverging incomes. These income differentials may be attributed to one or both of the following factors: differences among fishermen in the quantity of catch and differences in fish prices received and input prices paid. This cannot be directly determined by casual examination of the catch and price data because of the multispecies composition of catch and the use of a variety of mesh sizes that precludes even standardization of catch and price by species.

Although the importance of price differentials is not denied, the present study attempts to explain differences in fishing incomes arising from differences in catch, which may arise, in turn, from:

- Differences in the use of fishing inputs;
- Differences in resource availability among locations and resource accessibility among different types of gear;
- Difference in technical efficiency; and
- Random factors, such as "pure" luck.

In attempting to explain variations in catch in terms of the above factors, we define an input-output relationship, known as the "fishery production function" and apply it to the 1978 cross-sectional data on coastal fishing units from four locations — Chumporn, Nakhon Si Thammarat, Trat, and Pang Nga — to test the general hypothesis that differences in catch among small-scale fishermen are due to differences in production technology, variable input use, and resource abundance. These tests enable us to identify and rank the main determinants of catch and suggest ways in which catch and profit might increase.

Theoretical Framework

Following the conceptual framework described by Panayotou (this volume, p. 95) we specify a fishery production function relating catch to the components of fishing effort or fishing inputs:

$$Q = F(E_1, E_2, ..., E_7, E_8) \quad [1]$$

Where Q is an index of catch constructed by adding the quantities of individual species caught weighted by their prices (differential monopsony is assumed away); and $E_1, E_2, ..., E_8$ stand, respectively, for length of boat, tonnage, engine horsepower, fuel, mesh size, length of gear, labour, and fishing time.

For econometric estimation with empirical data, equation [1] was given a Cobb-Douglas functional form and stochastic specification. In log-linear form, the estimated equation is:

$$\begin{aligned} lnQ &= lnA + a_1 lnE_1 + a_2 lnE_2 + ... + a_7 lnE_7 \\ &\quad + a_8 lnE_8 \\ &= a_0 + a_1 lnE_1 + a_2 lnE_2 + ... \\ &\quad + a_8 lnE_8 + \mu \end{aligned} \quad [2]$$

Where a_i s are parameters and μ is an error term with appropriate properties.

Using ordinary least-squares techniques, equation [2] can be estimated for different types of fishing gears and locations. As a result, the following can be obtained: the technological coefficients of various fishing inputs by type of gear and location (a_i s); the marginal products of fishing inputs used ($MP = a_i Q E_i^{-1}$); the "catch elasticities" of fishing inputs (a_i s); returns to scale ($RTS = a_1 + a_2 + ... + a_8$); and the degree of price efficiency in input use ($VMP_i - P_i$). (For more details on the derivation and calculation of these measures, see Panayotou, this volume, p. 95.)

The most common specification error in studies of production relations involves the omission of variables related to management factors. According to a study by Mundlak (1961: 56–60), the effect of introducing better management is to shift the entire production function to the right, thus producing more output from a given amount of resources. This change is reflected in an increase in the marginal productivity of each input factor. These proxies for management will be included as shifts in the intercept of the production function. Hence, equation [2] becomes:

$$lnQ = a_0 + a_1 lnE_1 + a_2 lnE_2 + \ldots + a_8 lnE_8 + b_1M_1 + b_2M_2 + \ldots + b_7M_7 + \mu \qquad [3]$$

Where M_1, M_2, ..., M_7 are dummy variables representing age, education, experience, sex, marital status, religion, etc. Equation [3] may be estimated using ordinary least-square techniques.

Data Collection

The present study employs cross-sectional data on small-scale fisheries in four provinces — Chumporn, Nakhon Si Thammarat (Nakhon for brevity), Trat, and Pang Nga. The data were collected through survey interviews by the Department of Agricultural Economics, Kasetsart University, as a part of its research project, "The Socieconomic Conditions of Coastal Fishermen in Thailand," supported by IDRC.

Table 1. Sample fishing units from four coastal provinces by type of gear and location, Thailand.

Gear type	Chum-porn	Nak-hon	Trat	Pang Nga	Total
Drift gill net[a]	42	34	45	39	160
Push net	14	33	11	8	66
Trawl	14	63	5	0	82
Set bag net	0	8	0	17	25
Purse seine	12	0	0	0	12
Cast net	37	0	0	0	37
Winged lift net	0	27	0	0	27
Longline	0	11	0	0	11
Trap	0	0	20	0	20
Shell rake	0	0	13	0	13
Total	119	176	94	64	453

[a]Drift gill net, as used in this study, includes all three main types common in Thailand — fish gill net, shrimp gill net, and crab gill net.

The interviews were conducted during April 1979 and the survey covered the information on the preceding year's activities. (For more details on the selection of project sites and samples, see Panayotou et al., this volume, p. 55.)

The fishing units included in this study are only those with at least one member engaged in fishing as a fishing-unit owner-operator, a common characteristic of small-scale fisheries, and those with a motor boat using only one gear are included. Because the production function is estimated for each gear, and the sample of fishing units with more than one type of gear was too limited to allow sufficient degrees of freedom for econometric estimation, those using more than one gear were omitted. On the basis of these criteria, a total sample of 453 fishing units from the four provinces, using 10 different types of gear, were used in the estimation (Table 1).

Estimation by Type of Gear and Location

The first attempt was to estimate the production function specified in equation [2] for each type of gear in each province, assuming that fishing units operating in the same place at the same time were exploiting the same fishery resource. This is not an unrealistic assumption when only one type of gear is involved. Based on equation [3] for all types of gear, 19 regression equations were estimated.

The results of the estimation by individual gear group were not entirely satisfactory because of the small sample size, the wide range of observed values, and multicolinearity among the independent variables. The correlation among the explanatory variables was often higher than that between them and the dependent variable (catch).

To improve the results, some of the independent variables were omitted to allow selection of the best set of explanatory variables. The criteria employed were the level of adjusted R^2 ($\bar{R}^2$) and the statistical significance of individual regression coefficients. Only 9 of 19 regressions yielded significant results that could explain between 37%, drift gill net in Trat, and 71%, longline in Nakhon, of the total variation in catch.

The next attempt was to include management ability, i.e., equation [3]. The overall results improved considerably (Table 2) especially for purse seine and trawl in Chumporn, push net in Nakhon, drift gill net in Trat, and drift gill net and set bag net in Pang Nga. Four more estimations — push net in Chumporn and trawl, set bag net, and winged lift net in Trat — gave statistically significant results. Management ability had no explanatory power for drift gill net in Chumporn and drift gill net and longline in Nakhon. The regressions could explain from 24%, winged lift net in Nakhon,[1] up to 93%, set bag net in Nakhon, of the total variation in the index of catch.

The coefficient of the length of boat was statistically significant for trawl in Chumporn and drift gill net in Pang Nga. A 1% increase in length of boat (average lengths of boat for these groups were 10 and 9 m respectively) could increase the catch by 1.4%.

The coefficient of tonnage was statistically significant and positive for drift gill net and trawl in Chumporn, push net and longline in Nakhon, and drift gill net in Trat. The coefficient of tonnage of trawl in Nakhon was significant but negative: a 1% increase in tonnage could reduce the catch by 0.3% suggesting that the fishermen in this group might have been using unnecessarily large vessels.

The coefficient of horsepower was positive and significant for drift gill net in Chumporn, drift gill net and set bag net in Nakhon, and set bag net in Pang Nga; but negative and significant for push net in Nakhon, again suggesting that the boats were too powerful. This supposition is supported by the relative positions of horsepower for push net in Nakhon, 21.6, compared to the average of 11.4 in Nakhon and 11.3 for the total sample.

The length of gear had statistically significant and positive effects on catch in the case of drift gill net in Nakhon and set bag net in Pang Nga as would be expected because the catch in these types of gear depends crucially on the area covered. The larger the mesh size, the lower was the output for purse seine in Chumporn, and push net and set bag net in Nakhon. This follows the general rule that the smaller the mesh size, the lower the rate of "escape" and hence the higher "catchability" coefficient. However, the coefficient of mesh size for trawl in Chumporn was positive. When one considers that the nets of Thai trawlers are already too fine, smaller mesh sizes might result in inefficiencies in terms of more dragging weight, slower speed, and frequent gear damage and hence higher rate of escape than that with larger mesh sizes. (This explanation, however, warrants further investigation because of its implications for fisheries regulation.)

The coefficient of fuel was significant and positive for longline in Nakhon, drift gill net in Trat, and drift gill net and set bag net in Pang Nga.

The coefficient of labour was significant and positive for purse seine in Chumporn, drift gill net, push net, trawl, and longline in Nakhon, drift gill net in Trat, and drift gill net and set bag net in Pang Nga.

The coefficient of fishing time was significant and positive only in the case of drift gill net in Pang Nga where a 1% increase in fishing time would increase the catch by 0.35%. The significant and negative coefficient of fishing time for drift gill net in Nakhon suggests that excessive fishing time was spent by this gear group.

If the objective is to increase fish production, the results in Table 2 suggest that the use of more labour and fuel should be recommended in most cases. An increase in vessel length might be appropriate for drift gill net in Pang Nga and trawl in Chumporn whereas greater tonnage would be expected to result in a larger catch for drift gill net and trawl in Chumporn, push net and longline in Nakhon, and drift gill net in Pang Nga but not for trawl in Nakhon. Engine horsepower could be increased with a positive effect on catch for drift gill net in Chumporn, drift gill net and set bag net in Nakhon, and set bag net in Pang Nga and increasing the length of gear is recommended for drift gill net in Nakhon and set bag net in Pang Nga. However, a finer mesh size would be a more appropriate change for purse seine in Chumporn and push net and set bag net in Nakhon: although the reverse holds for trawl in Chumporn. Fishing time should be reduced for trawl and drift gill net in Nakhon but should be increased for drift gill net in Pang Nga.

Considering the proxies for management ability, older fishermen were found to be less efficient than young ones for purse seine in Chumporn and drift gill net in Trat; it should be noted, however, that the regression coefficients of age, which reflect the elasticities of catch with respect to age, were relatively low (−0.026 and −0.014). For push net and trawl in Chumporn, set bag net in Nakhon, and drift gill net in Pang Nga, the older fishermen did better than the younger. In Nakhon, fishermen with compulsory education had higher management ability in the cases of trawl and set bag net but were

[1]Despite a low $\bar{R}^2$, this regression could significantly explain much of the variation in catch considering that the computed F ratio (3.84) was higher than the critical F ratio (3.40) at the 5% level of significance.

Table 2. Estimated production function by types of fishing gear and location for the coastal fishery in four provinces, Thailand, 1978.

	Chumporn				Nakhon						Trat	Pang Nga	
	Drift gill net[a]	Purse seine	Push net[b]	Trawl[c]	Drift gill net[a]	Push net[c]	Trawl[b]	Set bag net[b]	Winged lift net	Longline[a]	Drift gill net[c]	Drift gill net[c]	Set bag net[c]
Variables													
Length of boat	–	–	–	1.377 (2.030)[d]	–	–	–	–	–	–	–	1.374 (1.914)	–
Tonnage	0.659 (3.246)	–	–	0.339 (2.096)	–	0.438 (4.259)	-0.302 (-2.693)	–	–	0.474 (2.090)	0.227 (2.817)	–	–
Horsepower	0.388 (2.499)	–	–	–	2.511 (5.063)	-0.634 (-6.568)	–	1.160 (4.232)	–	–	–	–	0.713 (2.128)
Length of gear	–	–	–	–	0.308 (2.126)	–	–	–	–	–	–	–	1.646 (4.877)
Mesh size	–	-0.829 (-2.618)	–	1.694 (3.006)	–	-0.307 (-3.193)	–	-1.250 (-2.742)	–	–	0.261 (2.067)	0.477 (2.797)	0.745 (3.276)
Fuel	–	–	–	–	–	–	–	–	–	0.653 (2.184)	0.103 (1.726)	0.293 (2.961)	0.617 (2.767)
Labour	–	0.760 (3.115)	–	–	0.496 (3.745)	0.401 (3.777)	0.209 (1.691)	–	–	0.622 (2.533)	–	0.353 (2.645)	–
Fishing time	–	–	–	–	-0.452 (-3.138)	–	–	–	–	–	-0.014 (-2.458)	0.465[e] (3.004)	–
Fisherman's age	–	-0.026 (-1.872)	0.593 (1.804)	0.603[e] (1.866)	–	–	–	1.816[e] (4.149)	–	–	–	–	–
Education 1	–	–	–	–	–	–	0.156 (2.059)	2.796[f] (5.209)	-0.817[f] (-2.616)	–	–	–	0.025 (2.301)
Education 2	–	–	–	–	–	–	–	–	-0.990[g] (-1.788)	–	–	–	–

Experience	–	–	–	–	–	–0.012	–	–	–	–0.019	–	–	–
						(–1.877)				(–1.739)			
Sex	–	–	–	–	–	–	–	–	–	–	–0.703	–	–
											(–2.352)		
Married	–	–	–	–	–	–	–	–	–	0.885	–	–	–
										(1.824)			
Widow(er)	–	–	–1.686	–	–	–	–	–	–	–	–	–	–
			(–2.922)										
Religion	–	–	–	–	–	–0.761	0.526	–	–	–	–	–	–
						(–3.383)	(2.910)						
Intercept	4.083	4.699	5.014	–1.301	–2.091	7.355	3.537	1.376	5.260	–0.618	3.952	–3.891	–5.853
Statistics													
R^2	0.458	0.766	0.447	0.731	0.562	0.750	0.322	0.928	0.242	0.848	0.464	0.599	0.746
$\bar{R}^2$	0.430	0.678	0.346	0.612	0.501	0.692	0.276	0.832	0.179	0.595	0.379	0.538	0.630
S	0.894	0.441	0.500	0.514	0.542	0.369	0.677	0.390	0.691	0.352	0.399	0.457	0.409
F	16.452	8.733	4.438	0.117	9.286	12.987	6.896	9.681	3.839	5.558	5.481	9.842	6.452
n	42	12	14	14	34	33	63	8	27	11	45	39	17

Note: Results given here are significant at least at the 90% level of confidence. Those for cast net in Chumporn; trawl, push net, trap, and shell rake in Trat; and push net in Pang Nga were not significant.

[a]Same results as when proxies for management ability were not included.

[b]Estimation was not significant when proxies for management ability were not included.

[c]Results were improved when proxies for management ability were included.

[d]Values in the parenthesis are *t* ratios.

[e]Age here is entered in dummy form taking the value of 1 if the fisherman was older than the average, 0 otherwise.

[f]Education here is entered in dummy form taking the value of 1 if the fisherman had compulsory education, 0 otherwise.

[g]Education here is entered in dummy form taking the value of 1 if the fisherman had higher education than compulsory level, 0 otherwise.

doing worse in the case of winged lift net than were those with more than compulsory education. This could be the result of the use of such primitive gear as winged lift net. Similarly fishermen with more years of experience in fishing were doing worse with push net and longline in Nakhon and set bag net in Pang Nga: possibly because new entrants have better equipment and use better techniques than those who have been fishing for many years.

Only in case of drift gill net in Trat were men doing worse than the women. However, there were very few women in this type of occupation. Among all small-scale fishing units, there were very few women operators and, except for gill netting in Trat, men were more successful as fishing-unit managers. Married fishermen were doing better than either single or widowers only in the case of longline in Nakhon but widowers were less successful than either single or married fishermen with push net in Chumporn.

Religion could explain part of differences in catch among fishermen only in the case of push net in Nakhon where Muslim fishermen were doing better than Buddhists and in the case of trawl in Nakhon where Buddhists were doing better than Muslims.

Estimation of Aggregate Production Functions

Aggregate production functions for all gear groups in all locations combined were estimated:

- To increase the degrees of freedom and offset the "excessive" variance in the individual samples; and
- To test the significance of resource abundance and other relevant characteristics of fishing gears.

For this purpose, the data for all types of gear from different provinces were combined into one sample. The assumption behind this grouping was that fishing effort was homogeneous across locations.

The differences in resource abundance and fishing ground, in general, were represented by a set of dummy variables: $L_1 = 1$ if the sample was from Chumporn; $L_2 = 1$ if the sample was from Nakhon; and $L_3 = 1$ if the sample was from Trat. (For details of regression with dummy variables, see Chow 1960; Snow 1977; Tokrisna 1979: ch. 4.) The sample from Pang Nga was taken as the base. The assumption behind this specification is that the differences in location affect catch through the corresponding differences in availability and accessibility of fishery resources. Of course, part of the differences in catch among locations are due to differences in the types of gears used, a factor accounted for through dummy variables (G_1, G_2, ..., G_9) representing nine different types of gear with gill net as a base gear because it was used in all four provinces. Thus, the aggregate function may be written as:

$$\begin{aligned} lnQ = {} & a + a_1 lnE_1 + a_2 lnE_2 + \dots + a_8 lnE_8 \\ & + b_1M_1 + b_2M_2 + \dots + b_7M_7 \\ & + c_1L_1 + c_2L_2 + c_3L_3 \\ & + d_1G_1 + d_2G_2 + \dots + d_9G_9 \end{aligned} \qquad [4]$$

The results of the estimation of equation [4] are given as "All" (second column) in Table 3. After irrelevant and statistically insignificant variables were dropped, the regression explained 57% of the variation in catch. Among the eight selected inputs, only three — tonnage, horsepower, and labour — were statistically significant. However, the coefficient of the overall horsepower was negative indicating that fishermen might have been using engines that were too powerful. The input elasticity was highest for labour: a 1% increase in labour (average use of labour was 39.8 man-days/month) could increase the catch by 0.23%. The proxies for management ability and the dummy variables for locations could not explain any statistically significant part of the variation in catch: such failure might be due to multicolinearity among these variables, excessive variation in the combined sample of observations, or simply lack of explanatory power in these variables.

Among different types of fishing technology, the efficiencies of drift gill net, trawl, and longline were about equal but winged lift net was less efficient and push net, cast net, set bag net, trap, purse seine, and shell rake were more efficient. Push net and drift gill net were found in all four provinces and trawl was used in all provinces except Pang Nga. The most efficient types of gear were purse seine, trap, and cast net — although shell rake was apparently more efficient than these, it was found only in Trat. Set bag nets, although ranking fourth in terms of technical efficiency, should not be recommended because most have illegally fine mesh.

To capture the differences in fishing abundance among different locations, regression equation [4] without L_1, L_2, and L_3 was estimated for each project site (Table 3).

In Chumporn, the most effective types of gear were purse seine, cast net, drift gill net, push net, and trawl in that order. In Nakhon, push net was the most effective gear followed by set bag net, trawl, and longline, next came winged lift

Table 3. Estimates of an aggregate production function for the coastal fisheries in four provinces, Thailand, 1978.

	All[a]	Chumporn	Nakhon	Trat	Pang Nga
Variables					
Length of boat	–	0.824 (1.977)[b]	–	–	–
Tonnage	0.180 (3.360)	0.242 (2.260)	–	0.122 (1.777)	–
Horsepower	–0.151 (–2.893)	0.205 (2.125)	–0.198 (–3.114)	–	–
Length of gear	–	–	–0.097 (–2.044)	–	0.309 (1.883)
Mesh size	–	–	–0.166 (–1.748)	–0.154 (–2.570)	–
Fuel	–	–	–	0.275 (3.618)	–
Labour	0.234 (5.110)	–	0.229 (2.993)	–	–
Fishing time	–	–	–	–	0.311 (2.209)
Push net	0.258 (2.037)	–1.252 (–4.749)	1.744 (9.001)	–2.465 (–11.056)	1.577 (2.217)
Trawl	–	–1.902 (–6.685)	0.913 (4.665)	–2.200 (–9.645)	ng
Set bag net	1.001 (5.175)	ng	1.662 (5.782)	ng	1.775 (4.065)
Purse seine	3.401 (12.435)	2.490 (8.939)	ng	ng	ng
Cast net	0.589 (3.771)	0.337 (1.855)	ng	ng	ng
Winged lift net	–0.420 (–2.322)	ng	–	ng	ng
Longline	–	ng	0.658 (2.375)	ng	ng
Trap	1.175 (5.711)	ng	ng	–	ng
Shell rake	4.393 (16.573)	ng	ng	2.423 (8.395)	ng
Fisherman's age	–	–	–	–0.213[c] (–2.029)	0.281[c] (1.922)
Education	–	–	–	–	0.263[d] (1.675)
Married	–	–	–	–	–1.224 (–2.182)
Intercept	4.681	3.507	4.160	4.626	2.092
Statistics					
R^2	0.570	0.729	0.527	0.921	0.463
$\bar{R}^2$	0.561	0.712	0.502	0.915	0.386
S	0.877	0.762	0.725	0.478	0.518
F	58.645	42.622	20.572	143.136	5.947
n	453	119	176	94	64

Note: ng = fishing gear not found in this province.
[a]The dummies for location and the proxies for management ability were included but were not statistically significant.
[b]Values in parentheses are *t* ratios.
[c]Age is entered as a dummy variable taking the value of 1 if the fisherman is older than the average, 0 otherwise.
[d]Education is entered as a dummy variable taking the value of 1 if the fisherman had compulsory education, 0 otherwise.

net and drift gill net with equal efficiency. In Trat, shell rake ranked first followed by drift gill net then trawl and push net in that order. Among the three gear types in Pang Nga, set bag net was most effective followed by push net and then drift gill net.

The regression results given in Table 2 were judged as superior to those in Table 3 and were selected as better proxies of the production technologies embodied in the different types of gears currently in use. The results in Table 3, nevertheless, are useful in comparing the efficiency of different fishing gears in different locations. Further calculations are based mainly on the results in Table 2.

Returns to Scale and Price Efficiency

The returns to scale were obtained as the sum of the coefficients of inputs used. Increasing returns to scale were found for set bag net in Pang Nga, drift gill net and longline in Nakhon, and trawl net in Chumporn. Constant returns to scale were found for set bag net in Nakhon and drift gill net in Chumporn and Pang Nga; and decreasing returns to scale were found for purse seine in Chumporn, drift gill net in Trat, and push net and set bag net in Nakhon.

Up to this point, we have considered aspects of fishing operations pertaining to technical efficiency. However, price efficiency is also a necessary condition for profit maximization. Maximum profit is obtained when each input is used at the level that gives rise to equality between the value of its marginal product (VMP_i) and its price (P_i).

If this equality is not satisfied, an increase in those inputs for which VMP_i is greater than P_i and a decrease in those for which VMP_i is less than P_i would increase profits. By calculating the marginal products and using the input and output price data obtained from the cost structure and profitability analysis study under the same project (see Panayotou et al., this volume, p. 163), the degree of price efficiency in input use is assessed (Table 4) by comparing the value of the marginal product of each input to its price. However, not all inputs are included. Although it is possible to calculate the value of the marginal product for each input, inputs such as the various characteristics of gear (e.g., length and mesh size) and "fishing time" have no observable prices. In other cases, such as tonnage or length of boat and horsepower of engine, a price can be calculated although its meaning is somewhat dubious.

The length of the vessels of all gear groups is below the optimum (profit maximizing) length (Table 4). Tonnage is below optimum for drift gill net in Chumporn, for push net in Nakhon, and for longline and drift gill net in Trat; it is about optimum for trawls in Chumporn, especially for those operated by older fishermen; and it is above optimum for trawl in Nakhon. Horsepower is below its profit-maximizing level for drift gill net in Chumporn and Nakhon and for set bag net in Nakhon and Pang Nga, but it is above the optimum in push net in Nakhon. Excessive fuel was used by longline operators in Nakhon and less experienced set bag net operators in Pang Nga. Use of more fuel would be profitable for more experienced set bag net operators in Pang Nga and female drift gill net operators in Trat. The use of fuel by male drift gill net operators in Trat and drift gill net operators in Pang Nga in general was close to the optimal level. Finally, too much labour was used by purse seine operators in Chumporn, male operators of drift gill net in Trat, and drift gill net operators in general in Pang Nga. Additional labour could be profitably employed by push net, trawl, and longline operators in Nakhon. The use of labour by female operators of drift gill net in Trat and drift gill net operators in Nakhon in general was nearly optimal.

To sum up, our results indicate that it would be profitable for the less traditional types of gear to increase the size and engine power of their vessels, whereas operators of the more traditional types of gear should increase the use of labour. Increase in fuel use under the prevailing prices would reduce rather than increase profits.

Input Interaction

To investigate the extent of input interaction, an attempt was made to explain variations in catch through an aggregate *translog* production function, which, in a two-input (E_1, E_2) case, may be written as:

$$\begin{aligned} lnQ = {} & a_0 + a_1 lnE_1 + a_2 lnE_2 \\ & + 0.5\, a_{11}(lnE_1)^2 + a_{12} lnE_1 lnE_2 \\ & + 0.5\, a_{22}(lnE_2)^2 \end{aligned} \qquad [5]$$

In one specification, no distinction was made among gear types or locations. The entire sample of 453 fishing units was treated as if it came from the same population of identical gear and location. Vessel tonnage, mesh size, and the square of horsepower were significant in their own right, and also had significant interactions with each other as well as with other inputs that

Table 4. Economic efficiency of the coastal fishery in four provinces, Thailand, 1978.

	Boat									
	Length		Tonnage		Horsepower		Fuel		Labour	
	P_i	VMP	P_i	VMP	P_i	VMP	P_i	VMP	P_i	VMP
Chumporn										
Drift gill net	–	–	68.41	621.58	6.88	31.77	–	–	–	–
Purse seine	–	–	–	–	–	–	–	–	23.58	16.24
Trawl	51.02	75.88[a] 138.72[b]	176.88	97.31[a] 177.90[b]	–	–	–	–	–	–
Nakhon										
Drift gill net	–	–	–	–	6.62	755.89	–	–	25.61	27.69
Push net	–	–	8.17	3012.49[c] 1407.22[d]	1.70	-297.8[c] -717.73[d]	–	–	25.24	108.19[c] 51.68[d]
Trawl	–	–	52.68	-1547.15[c] -2168.26[d]	–	–	–	–	19.04	23.68[c] 40.08[d]
Set bag net	–	–	–	–	1.06	53.26[e] 327.71[f] 872.56[g] 5366.33[h]	–	–	–	–
Longline	–	–	25.97	834.81[i] 2023.25[j]	–	–	4.74	0.67[i] 1.62[j]	16.41	22.01[i] 52.37[j]
Trat										
Drift gill net	–	–	48.55	2968.08[k] 1468.91[l]	–	–	2.35	4.22[k] 2.11[l]	48.51	52.59[k] 26.05[l]
Pang Nga										
Drift gill net	3.78	1071.49[a] 673.13[b]	–	–	–	–	4.63	5.80[a] 3.68[b]	25.31	18.15[a] 11.40[b]
Set bag net	–	–	–	–	4.10	680.83[m] 663.99[n]	4.64	1.00[m] 9.20[n]	–	–

[a]Younger fishermen.
[b]Older fishermen.
[c]Muslim fishermen.
[d]Buddhist fishermen.
[e]Younger, less educated fishermen.
[f]Older, less educated fishermen.
[g]Younger, more educated fishermen.
[h]Older, more educated fishermen.
[i]Married fishermen.
[j]Single or widower fishermen.
[k]Female fishermen.
[l]Male fishermen.
[m]Less experienced fishermen.
[n]More experienced fishermen.

were not individually significant. Although the direct effect of (larger) mesh size on catch was positive, its interaction with tonnage, horsepower, and fuel consumption was negative, signifying the need for larger vessels and more fuel to obtain the same catch as with smaller mesh size. Labour, although not a significant determinant of catch on its own, contributed significantly to catch through its interaction with tonnage and fuel. Similarly, the length of net contributed to a larger catch through its interaction with tonnage.

In an alternative specification, the sample was stratified by gear type. No individual input or its square (interaction with itself) was found to be significant except for labour. Most cross-interaction terms, however, were statistically significant at a reasonable level. After eliminating the insignificant terms, the estimated model and parameter values obtained were:

$$
\begin{aligned}
\ln Q = {} & \underset{(5.895)}{5.223} + 0.032(\ln L)^2 - \underset{(-4.612)}{0.140 \ln B \ln N} \\
& - \underset{(-2.437)}{0.082 \ln B \ln M} + \underset{(4.941)}{0.049 \ln T \ln N} \\
& + \underset{(3.656)}{0.068 \ln N \ln M} + \underset{(2.814)}{0.023 \ln N \ln F} \\
& + \underset{(10.734)}{3.029 G_1} - \underset{(-2.818)}{0.381 G_3} + \underset{(1.690)}{0.314 G_4} \\
& + \underset{(5.110)}{0.995 G_5} - \underset{(-3.222)}{0.611 G_6} + \underset{(5.330)}{1.120 G_8} \\
& + \underset{(13.963)}{3.802 G_9}
\end{aligned}
\qquad [6]
$$

$$R^2 = 0.605,\ \bar{R}^2 = 0.593,\ S = 0.8444,$$
$$F = 51.701,\ n = 453$$

Where Q is catch in value terms, L is labour, B is length of boat, N is length of net, M is mesh size, T is gross tonnage of boat, and F is fuel; G_1 to G_9 are dummy variables representing different types of gear — purse seine (G_1), push net (G_2), trawl (G_3), cast net (G_4), set bag net (G_5), winged lift net (G_6), longline (G_7), trap (G_8), and shell rake (G_9); R^2 is the coefficient of determination, $\bar{R}^2$ is R^2 adjusted for the degrees of freedom, and values in parentheses are *t* statistics.

As can be seen from these results, there is significant interaction among fishing inputs. It is remarkable that about 60% of all variation in catch was explained by interaction terms, including that of labour with itself. Mesh size had a negative interaction with the length of boat and a positive interaction with the length of net. In addition to this interaction, the length of net interacted positively with vessel tonnage and fuel and negatively with the length of boat. The increased role of the length of net and decreased role of mesh size with the stratification of the sample into gear types is worth noting. Seven of the eight types of gear tested were found to differ significantly in productivity from the base gear (drift gill net). Shell rake, purse seine, trap, set bag net, and cast net, in that order, were found to be technically more efficient (productive) than drift gill net, whereas winged lift net and trawl were found to be less efficient. This second specification was more satfisfactory than the first, which explained only 32% of the variation in catch. Location, introduced in a third regression, was found to lack explanatory power.

Summary of Findings and Policy Implications

The present study had the following six objectives:

- To identify the factors that can explain variations in catch among fishermen;
- To quantify the contribution of each of these factors to catch;
- To determine whether coastal fishing is characterized by increasing, constant, or decreasing returns to scale;
- To compare the technical efficiency (productivity) of different fishing technologies (gears) in each fishing ground;
- To determine the degree of economic deficiency in input use; and
- To examine the degree of interaction among fishing inputs.

The data indicate significant differences in catch between different types of gear and between different locations. Due to multicolinearity and excessive variation, we could not directly compare the differences in catch between different types of gear and different locations simultaneously. Nevertheless, our findings suggest that the differences in catch can be explained both by fish accessibility through different types of fishing gear and by fish abundance in different locations.

The catch with drift gill net in Chumporn could be increased by increasing tonnage and horsepower. Although there is room for increasing catch from drift gill net in Nakhon by increasing engine power, length of gear, and labour, a reduction in fishing time could also contribute to higher catch as the group appears to have been engaging in trips that were too long with adverse effects on vessel maintenance and crew efficiency. Increasing tonnage, fuel, and labour could increase the catch of drift gill net in Trat, and increasing length of boat, fuel, and labour could increase the catch of drift gill net in Pang Nga.

For purse seines, which are found only in Chumporn, finer mesh size would lead to higher catch as expected (present average mesh size was 2.3 cm); however, whether this is appropriate would depend on the condition of the resource stock and the resource management objectives of the government. It might be preferable to increase labour use, especially in a labour-surplus country such as Thailand, because it was found that a 10% increase in labour use would increase catch by 7.6%.

For push net, a gear type found in all four provinces, satisfactory results were obtained only in the case of Nakhon: a 10% increase in tonnage and labour could increase catch by 4.4 and 4.0%, respectively, whereas increasing engine power and mesh size would reduce the catch. This suggests that push net in Nakhon might have been using too little labour, excessive engine power, and too fine nets, a combination that may have weakened its catching power.

Successful but varied results for trawl were obtained for Chumporn and Nakhon. In Chumporn, the size of vessel should be increased: a 10% increase in the length and tonnage of boat would increase catch by 1.4 and 3.4% respectively. The mesh size of trawl in Chumporn is already too fine and a larger mesh size might, in fact, result in higher catch as an excessively fine mesh slows down the vessel and increases the rate of escapement. In Nakhon, increasing the size of vessel tonnage would reduce the catch but a 10% increase in labour could increase the catch by 2.1%.

For set bag net in Nakhon, the catch could be increased by increasing engine power. Also, using finer mesh size could increase the catch, which partly explains the large catches of high-powered vessels, which can withstand the drag of a heavier net. In Pang Nga, increasing engine power, length of gear, and fuel could increase the catch for this type of gear.

Longline was found only in Nakhon where a 10% increase in tonnage, fuel, and labour could increase catch by 4.7, 6.2, and 6.2%, respectively.

It is worth noting that for relatively more advanced fishing gears, such as drift gill net and trawl, increases in vessel size (length and tonnage) are recommended, except for tonnage of trawl in Nakhon. For semitraditional gear, such as push net, increases in vessel tonnage and labour are recommended. Horsepower was a significant explanatory variable in the case of set bag net even though it is a stationary gear; the explanation may lie in the use of a boat for "hit-and-run" operations because the bag net is a prohibited gear due to its fine net and potential use in spawning areas.

To sum up, on productivity grounds alone, the following input changes would be most beneficial:

- Increases in length of boat for drift gill net in Pang Nga, in tonnage for push net in Nakhon, in engine power for set bag net in Nakhon, in length of gear for set bag net in Pang Nga, in fuel for drift gill net in Pang Nga, in labour for push net in Nakhon, and in fishing time for drift gill net in Pang Nga; and
- Decreases in mesh size for push net and set bag net in Nakhon.

It must be kept in mind, however, that these changes are based on productivity considerations alone and are not the final word on the matter. Changes dictated by profitability and resource conservation are discussed elsewhere.

The effect of management ability, or its proxies, turned out to be significant for only some groups of fishing gear in some locations (see Table 2). Age could explain variation in catch for purse seines and push nets in Chumporn and set bag nets in Nakhon. In the case of purse seines in Chumporn, younger fishermen appear to be better managers, which might be due to the fact that purse seines are relatively new, high-return, and high-risk gear and younger fishermen are more willing to take risks. Older fishermen did better than younger ones with traditional types of gear such as push nets and set bag nets.

Fishermen with higher education did better with modern gear, such as trawls in Nakhon, and worse with traditional stationary gear, such as winged lift nets at the same location. Higher education appears to be more important for less traditional gear.

Experience in fishing was significant only in the cases of push net and longline in Nakhon, but in a negative way: fishermen with more experience were doing worse than those with less experience. Two explanations might be possible: first, new entrants are operating, on the average, more modern or, at least, newer equipment and, second, because of the asymmetry of entry and exit into the industry, exit might be more difficult than entry — those who have been in the industry for the longest time may be inefficient or marginal operators.

Differences in the marital status of fishermen could explain part of the variation in catch in only a few cases. Religion had explanatory power only in the case of Nakhon where Muslims were found to have a comparative advantage for operating push nets and Buddhists for operating trawls.

The results suggest that different management ability among different gear types in different locations can help explain a large part of the variation in catch, implying that operators with more management ability, other things being equal, do catch more fish.

It is difficult to determine the technically "most efficient" gear type. Our findings suggest that catching power depends not only on the type of fishing gear, but on the resource abundance as well. The same type of gear may be effective in one location and ineffective in another depending on the resource stock situation and the morphology of the coast in different locations. The results in Table 3 suggest that, overall, the most effective gear type was shell rake[2] (4.4 times more efficient than the base gear, drift gill net) followed by purse seine (3.4 times more efficient); the least efficient gear was winged lift net (0.4 times less efficient than the base gear). In terms of location, purse seine was most productive in Chumporn, push net in Nakhon, shell rake in Trat, and set bag net in Pang Nga.

The shell rake proved to be the most effective technology for increasing production; however, shell rakes were found only in Trat. Other efficient technologies were also location-specific:

[2]This is not due to the bulkiness of shells because productivity and output are measured in terms of gross value.

purse seine was found only in Chumporn and trap only in Pang Nga; cast net, the next best type of gear, was found only in Chumporn; and set bag net was found in Nakhon and Pang Nga. The latter type of gear is not recommended in its present configuration because of its unduly fine mesh size. Push net was one of the few type of gears found in every location and is recommended for Nakhon and Pang Nga whereas drift gill net, which was also found in all four locations, appear to be appropriate for Chumporn and Trat.

Increasing returns to scale were found for set bag net in Pang Nga, drift gill net in Nakhon, trawl net in Chumporn, and longline in Nakhon; constant returns to scale for set bag net in Nakhon and drift gill net in Chumporn and Pang Nga; and decreasing returns to scale for purse seine in Chumporn, drift gill net in Trat, and push net and set bag net in Nakhon.

Regarding price efficiency, we found that it would be profitable for less traditional types of gear to increase the size and engine power of their vessels whereas more traditional types of gear should increase the use of labour. Increase in fuel use under the prevailing prices would reduce rather than increase profits for most gear groups. Several types of gear, such as longline in Nakhon and set bag net operated by inexperienced fishermen in Pang Nga, could in fact increase their profits by using less fuel. Similarly purse seine operators were using too much labour: this is socially desirable, although privately uneconomical, when considering the already high profitability of purse seines and the considerable unemployment in coastal fishing communities. In fact, all types of gear should be encouraged to employ more labour; many should be advised to do so for their own benefit (higher profits) and the rest should be given incentives in this respect.

Finally, it was found that significant interactions among inputs do exist and suffice to explain over 60% of the variation in catch. Most notable are the interaction of labour with itself, of mesh size with the length of boat (negative) and with the length of net (positive), and length of net with vessel tonnage and fuel (positive) and with length of boat (negative).

The presence of significant input interactions has policy implications for both development assistance and fisheries regulation. Supplying input "packages" may be more effective in increasing production than when inputs are provided individually. Analogously, the regulation (restriction) of the use of an input in the presence of input interactions might reduce catch by more than it would in their absence.

Production Technology of the Riverine Fisheries in Bangladesh

Mohammed S. Khaled

Introduction

Fisheries are an important resource of Bangladesh. In 1979-80, they contributed 5% to the gross domestic product (GDP) and 6% to export earnings. Fish, a staple food, supplies 80% of total animal protein consumption. Fishing and related activities directly or indirectly provide employment to about 6% of the population (Bangladesh, Planning Commission 1980). The current position of the fisheries in the economy of Bangladesh, however, falls far short of its potential contribution.

In Bangladesh, it is the small-scale inland fisheries that dominate (Bangladesh, Bureau of Statistics 1979a:260–263). During 1977–78, these fisheries supplied 88.6% of a total of 835 000 t (metric) of fish caught and 71% of a total of 999 506 fishermen were employed in the inland fisheries: marine fishing is still at its infancy in Bangladesh. Given the present trends of investment in marine fishing, it is expected that inland fishing will continue to dominate fisheries in Bangladesh. Even in the terminal year (1984–85) of the Second 5-Year Plan, the inland fisheries are expected to account for 83.5% of the total catch of fish.

Bangladesh is called a land of rivers and the inland fisheries are dominated by the riverine fisheries. During 1977–78, rivers and canals made up 65% of an aggregate of 1.28 million ha of perennial inland fisheries. During this year, *hilsa*, only one of the various species of riverine fish, amounted to 52% of the total weight of fish caught from inland waters.

This paper is devoted to an economic analysis of the riverine fisheries, the most important source of fish in Bangladesh.

The problem

The riverine fisheries are a renewable common-property resource. It is well known that unless properly managed, such resources are overexploited in equilibrium (see, for example, Anderson 1977:30–32), and fishing is carried out beyond the level at which net social revenue is maximized. Indeed in the free-access equilibrium, the surplus of revenue over cost is zero. On the one hand, revenue declines due to degradation of the stock of fish and, on the other, the cost of catching a given amount of fish rises due to overcrowding. The distinct nature of these two aspects of open-access equilibrium has been pointed out by Philip Neher (University of British Columbia, Canada) in recent seminars and in discussion.

The riverine fisheries in Bangladesh are not properly managed. The present system is to lease out the fishery to the highest bidder on a yearly basis. The leaseholder then collects tolls, related to the type of net, from the fishermen. The only other governmental intervention in riverine fishing is the East Bengal Protection and Conservation Act of 1950 that forbids catching of fish smaller than 9 inches (22.86 cm) in length. Because there is no guarantee that a lessee will get the lease of the same fishery in successive years, he behaves as if there is no future. He does not impose any restriction on the level of effort or on the size and amount of fish caught. He aims only at maximizing the toll revenues, which are a fixed cost to the fishermen. Thus, under the present system of management, the riverine fisheries of Bangladesh are characterized by free-access. It is conjectured that those fisheries are now at the open-access equilibrium where the social surplus is zero. It appears that the government is also resigned to such a state of affairs. Catch of fish from rivers is expected to remain virtually at the same level in the terminal year (1984–85) as in the benchmark year (1979–80) of the Second 5-Year Plan (Bangladesh, Planning Commission 1980). The riverine catch seems to have stabilized at this level and society is just breaking even with no surplus for further investment in its development.

The riverine fishermen in Bangladesh are perennially poor: they live from hand to mouth. This condition is in keeping with the fact that, in the open-access equilibrium, each fisherman is earning just enough to meet his costs.

The physical environment of riverine fishing has also been degraded due to such factors as large-scale silting of the rivers, extensive leakage of insecticides and fertilizer used in agriculture, and excessive removal of surface water.

An assessment of the effects of degradation of stock and environment on the catch of fish requires observations over time. Such data are, however, either nonexistent or very hard to come by in Bangladesh. In the present study, the problem of overcrowding in a fishery with a given stock of fish and physical environment is considered. Under these conditions, variation in catch of fish is due solely to differences in levels of effort. The level of effort is, in turn, the output of various fishing inputs (for such a formulation, see Panayotou and Kumpa 1980:10). Evaluating the productivities of the different inputs requires an estimation of the production technology.

Review of the literature

There has been no proper economic analysis of the fisheries of Bangladesh and the few studies that have been made tend to be descriptive in nature. For example, the study by Karim (1979) describes the position of the fisheries sector in the economy of Bangladesh, mentions a set of physical problems, and suggests some measures for improvement. The discussion on fisheries in the draft Second 5-Year Plan (Bangladesh, Planning Commission 1980) is similar. There is no discussion of the underlying production technologies of the different fisheries in the existing literature. Appropriate and reliable data on the fisheries are also few and far between. Consequently, discussion on fisheries in Bangladesh tends to be impressionistic and journalistic with little, if any, analysis.

An exception to this evaluation is the study by Mahbubullah (1979), which puts forward the view that interactions among ideology, power relations, institutions, and resource endowments in the riverine fisheries of Bangladesh perpetuate a "below poverty-level equilibrium." There is, however, no discussion of whether the existing production technology is being used efficiently under the given mode of production. A detailed analysis of the present production technology is needed for exploring possible improvement in fishing incomes even under the existing production relations.

Objectives of the study

The objectives of the present study are

- To estimate the production technology in the riverine fisheries of Bangladesh so as to analyze the productivities of the various inputs and substitutabilities among them;
- To evaluate the efficiency of resource allocation; and
- To examine the profitability of investment in fishing.

Theoretical Framework

The fisheries production function combines both biology and technology: biology is represented by fish stock and technology by fishing effort. The output or catch of fish (Y) depends on stock of fish (Z) and effort (E) (see Anderson 1977:24; Panayotou, this volume, p. 95):

$$Y = F(Z, E) \qquad [1]$$

This function is characterized by positive but diminishing marginal products of stock and effort. Fishing effort is itself an output of various fishing inputs — labour (X_1), boat (X_2), and net (X_3) — so that:

$$E = g(X_1, X_2, X_3) \qquad [2]$$

The effort production function [2] has the properties of constant returns to scale and positive but declining marginal productivities.

Combining [1] and [2], we obtain:

$$Y = F[Z, g(X_1, X_2, X_3)] \qquad [3]$$

a function that is homogeneously weakly separable into the inputs (X_1, X_2, and X_3) and fish stock (Z).

In a particular fishery, the stock of fish during a given fishing season is the same for all fishing units. Variation in catch for such fishing units is then due solely to variation in levels of effort. A simple representation of such a production function satisfying the characteristic of [1] is:

$$Y = cE^a; 0 < a < 1, c > 0 \qquad [4]$$

For the production function of effort, we specify a *translog* function (Christensen et al. 1973) satisfying the property of constant returns to scale:

$$lnE = \sum_i b_i lnX_i + 0.5 \sum_i \sum_j b_{ij} lnX_i lnX_j \qquad [5]$$

Where $\sum_i b_i = 1$, $b_{ij} = b_{ij}$, and $\sum_j b_{ij} = 0$ for all i s.

The Cobb-Douglas function is obtained as a special case of [5] if $b_{ij} = 0$, for all i s and j s:

$$lnE = \sum_i b_i \, lnX_i \qquad [6]$$

This function is, however, a priori characterized by unitary elasticity of substitution between the various inputs. The nature of technology in fishing is, however, such that substitutability between the different inputs is quite limited and some of the inputs may even be complementary. Here, the *translog* production function is more appropriate than the Cobb-Douglas function because, in the former, the elasticities of substitution between the various inputs can be different and less than unity.

The input elasticities (s_i) for the *translog* function are:

$$S_i = (\partial lnY)/(\partial lnX_i)$$
$$= a(b_i + \sum_i b_{ij} \; lnX_j); \text{ for all i s} \qquad [7]$$

Let us define

$$c_{ij} = ab_{ij} + s_i, s_j, i \neq j$$
$$c_{ii} = ab_{ii} + s_i(s_i - 1) \qquad [8]$$

The elasticity of substitution (s_{ij}) between inputs i and j in the three input *translog* functions is given by:

$$s_{ij} = \text{cof}(i,j)/\det(H) \qquad [9]$$

Where cof(i,j) is the cofactor of c_{ij} in the symmetric matrix:

$$H = \begin{bmatrix} 0 & s_1 & s_2 & s_3 \\ s_1 & c_{11} & c_{12} & c_{13} \\ s_2 & c_{12} & c_{22} & c_{23} \\ s_3 & c_{13} & c_{23} & c_{33} \end{bmatrix} \qquad [10]$$

and det(H) is the value of the determinant H. For a "well behaved" production function, the input elasticities are positive and the elasticities of substitution are negative.

The inputs receive the value of their marginal products if the elasticity of output to each input equals the share of the cost of the input in the total revenues:

$$s_i = (P_i \, X_i)/PY; \text{ for all i s} \qquad [11]$$

Where P and P_i are the prices of fish and input i respectively.

It can be noted that the sum of the shares equals the effort elasticity of output (a), which is a number less than unity, owing to diminishing returns to effort with a fixed stock. The share of rent due to the stock is then equal to $(1 - a)$.

Let S be the earning of boat (X_2) and net (X_3):

$$S = PY - P_1X_1 \qquad [12]$$

Where P_1X_1 is the cost of labour services, and stock rents are not being paid as in an open-access fishery. The profitability of investment in fishing can, in this case, be assessed by comparing the rate of return (S/K), where K is the present value of investment in fishing, with the opportunity cost i of the investment. If (S/K) is greater than i, investment in fishing is profitable.

Methodology of Data Collection and Preparation

The river system of Bangladesh consists mainly of three rivers — Meghna, Padma, and Jamuna — and *hilsa*, the principal riverine fish species, is caught in all three. This species is actually a sea fish that comes upstream from the Bay of Bengal into the Bangladesh river system for spawning. In this paper, we study the production technology of *hilsa* fishing.

Chandpur and Goalunda are the two biggest riverine fish-landing stations in Bangladesh. We have selected two locations — one in Chandpur on the River Meghna and the other in Padma near Goalunda on the River Jamuna. These two sites belong to the eastern and the western zones, respectively, of the Bangladesh river system but they could also be considered as belonging to the southern and northern zones respectively in the same river system. Thus, the riverine fishery in Bangladesh is fairly well covered by the fishermen living in those two locations.

Two villages in Chandpur — Nilkamal and Haimchar — representing the heaviest concentration of fishermen in the area were selected. At the site in Pabna, which is near Goalunda at the confluence of the rivers Padma and Jamuna, a cluster of six villages — Joinagar, Raksha, Natun Varenga, Ghior, Nakalia, and Maldahapara — were selected. These villages are much smaller than those in Chandpur.

The production unit in the riverine fisheries is a fishing team that is usually organized by the owner of boats and nets, who hires in labour. However, he may or may not actually go out with the team on a fishing expedition although he bears all the risks and is comparable to an entrepreneur in the theory of the firm. We refer to him as the team leader and, when he actually goes fishing, also as the team manager.

Our unit of study is, then, a fishing team. We administered a schedule of questions to the team leaders. Because the two villages in Chandpur are very big, we interviewed only a random sample of 81 team leaders in this location. In the Pabna site, where the villages are small, we surveyed the entire villages and the interview schedule was administered to all the 36 team leaders in the six villages.

The fisheries technology in Bangladesh continues to be the traditional one combining men, nets, and sailboats. The only touch of modern technology is the recent use of nylon nets. The nets for catching *hilsa* are basically of two types: drift nets (e.g., *chandi jal, dora jal, kona jal,* etc.) and seine nets (e.g., *dhora jal, tana ber jal,* etc.) described by Ahmed (1970:2–4). We utilize a dummy variable (X_4) to capture any difference between the net types.

The nets vary primarily in length (or weight) and number of men and boats required to operate them: mesh size does not vary much — typically it is 6.78 cm in Pabna and 7.62–8.46 cm in Chandpur. We have measured a net in terms of its weight, which appears to be the best single aggregate of length, breadth, and mesh size. The boats vary in length, width, and draft but the best single measure of their capacity is tonnage.

For estimating the fishing technology, we obtained data on catch of *hilsa* (Y), measured in maunds (1 maund = 37.3261 kg) and amount of labour in standard man-days (X_1) where 1 man-day equals 10 hours. We measured size of a boat by its tonnage expressed in maunds. When a team uses more than one boat, the tonnages of all boats are summed to give the size of boat (X_2) for the unit. Similarly, size of net (X_3) is measured by the total weight in maunds of all nets used by a team.

In estimating the production technology, we excluded the other inputs (floats and weights for keeping nets upright, sail of a boat, lanterns and flash lights, etc.), which are proportional either to size of net or to size of boat.

A phenomenon that is widespread in riverine fishing is accidental loss of boat and net for a part of the fishing season. This reduces the effective capacity of boat and net. Therefore, we measured effective capacity as:

$$X_i^* = X_i\,[1 - (u_i\, t_i / w_i T)];\ i = 2, 3 \qquad [13]$$

Where u_i is value of loss, w_i is value of the asset, t_i is duration of reduced capacity, and T is length of the fishing season. We then used effective size of boat and net in estimating the production technology.

The Chandpur and the Pabna sites differ in several respects. The fishermen in Pabna are mostly Hindus. The Hindu fishermen occupy the lowest stratum (Sudra) in the Hindu caste system. It is a sin for them to move into occupations reserved for the higher castes. The fishermen in the Chandpur location are all Muslims. Fishing by Muslims is a recent trend because Hindu fishermen have migrated to India since the partitioning of India in 1947. In addition, the continual erosion of the banks of the River Meghna in Chandpur has rendered the Muslim farmers there landless thus forcing them to become fishermen and concentrate in large numbers in single villages. Although becoming a fisherman is taboo for the Muslims, the fishermen in Chandpur reported that they had obtained permission from their *Pir* (spiritual leader) before adopting this occupation.

The two sites differ perhaps in fish stock and the fish caught in the two areas taste different — the water of the River Meghna is less muddy than that of the Jamuna. Although all the team leaders in Pabna actually participate in fishing, most of those in Chandpur do not. One other difference is that in Chandpur the toll paid to the lessee is a fixed amount depending upon the size and type of net, whereas that in Pabna is one-third of the value of fish caught. The latter method of taxing is more conducive to preservation of stock than the former.

To capture the effect of any structural difference between the two sites on the catch of fish, we use a dummy variable (X_5).

We also obtained data on prices. The price of fish per maund (P) and the wage of fishermen per man-day (P_1) are observable variables. The factor rewards in Chandpur are decided in the following manner. The expenses for food, fuel, minor repairs, etc. during a fishing expedition are subtracted from the gross revenues. Half of the remainder goes to the owner of the boat and gear; the other half is divided into equal parts so that the team manager (*majhee*) gets two parts and the others receive one part apiece.

The rental prices of boats (P_2) and nets (P_3) are usually nonobservables: these are durable inputs that are owned rather than hired. The purchase prices of these assets (q_i) are, however, observable. We can utilize the asset prices to compute the rental prices defined as:

$$P_i = [(r + d_i)q_i - \bar{q}_i]\,0.5 \qquad [14]$$

Where d_i and $\bar{q}_i$ are, respectively, the rate of depreciation and price of asset i, r is the rate of interest, and $\bar{q}_i$ is the rate of inflation of the asset price. We have taken the annual rate of interest (r) to be 12%: the rate given by the Bangladesh Krishi Bank to the savings accounts most commonly held by the fishermen in our sites. We have calculated the rate of depreciation per year as:

$$d_i = 1/N_i \qquad [15]$$

Where N_i is the estimated life of asset i in years.

We have computed the rate of capital gain ($\bar{q}_i$) as:

$$\bar{q}_i = (q_i^* - q_i)/n_i \qquad [16]$$

Where q_i^* is current purchase price of the asset i and n_i is present age of the asset in years. This derived value is the rental price per season. There are two fishing seasons in a year, each about 6 months long — winter season (the months *Kartik* to *Chaitra*, i.e., October to March) and the rainy season (*Baishak* to *Ashin*, i.e., April to September).

The present value of investment in fishing (K) is computed as the present estimated sale price of the assets (boat, nets, and other inputs) owned by the team leader. The return on investment in fishing (S) is measured as:

$$S = PY - P_1X_1 - t - W \qquad [17]$$

where P_1X_1 is the earning of labour, t is the amount of tax paid to the lessee of the fishery, and W is the organizational earning of the team leader. For a 6-month period (183 days), we imputed an organizational earning of 2301.19 BDT[1] for each team leader: this is based on a daily wage of 12.57 BDT obtained by inflating the daily wage (10.97 BDT) of a skilled worker in the fisheries sector in the year 1977–78 at the rate of 14.629%, which was the rate at which such wages rose in the previous year.[2] The amount of taxes paid (t) also needs explanation: although it is a fixed amount that depends on the type and size of net, the lessee may waive or lower the toll for a relative or friend or extort a rent in kind (fish) over and above the nominal rent from others.

The opportunity cost of investment in fishing is taken to be 6% per season: the rate of interest obtained in the type of savings account most commonly held by the people in our sites. The fishermen interviewed were mostly landless. In Chandpur, erosion of the riverside has made the Muslim peasants landless and forced them to become fishermen so that farming is not a feasible alternative to them. In Pabna, also, agriculture is not an available alternative to the predominantly Hindu fishermen who face a caste barrier in changing their occupation.

The fishermen in the two locations could, in theory, become labour fishermen and save the proceeds of disinvestment in fishing in a bank. The opportunity cost of investment in fishing to them is, then, the interest foregone by not saving in a bank.

Estimation and Results

The estimating equation is, from [4] and [5],

$$\begin{aligned} lnY = {} & lnc + a\,lnX_3 + ab_1 ln(X_1/X_3) \\ & + ab_2 ln(X_2/X_3) - 0.5ab_{12}[ln(X_1/X_2)]^2 \\ & - 0.5ab_{13}[ln(X_1/X_3)]^2 \\ & - 0.5ab_{23}[ln(X_2/X_3)]^2 + dX_4 \\ & + d_iX_5 + \mu \qquad [18] \end{aligned}$$

Where μ is assumed to be independently normally distributed with mean zero and constant variance. Computationally, this equation is of the form:

$$\begin{aligned} lnY = {} & c_0 + a\,lnX_3 + c_1 ln(X_1/X_3) + c_2 ln(X_2/X_3) \\ & + c_3[ln(X_1/X_2)]^2 + c_4[ln(X_2/X_3)]^2 \\ & + c_5[ln(X_2/X_3)]^2 + dX_4 + d_iX_5 + \mu \qquad [19] \end{aligned}$$

We have estimated equation [19] by the method of least squares. Computations were carried out in the IBM 370 computer at the Bangladesh University of Engineering and Technology.

The parameters a, d, and d_i were estimated directly in [19]. The other parameters were obtained as:

$$\begin{aligned} c &= \exp(c_0) \\ b_i &= (c_i/a);\ i = 1, 2 \\ b_{12} &= -(2c_3/a) \\ b_{13} &= -(2c_4/a) \\ b_{23} &= (2c_5/a) \end{aligned}$$

The estimates of the parameters b_3, b_{11}, b_{22}, and b_{33} were derived using the relations in [5].

According to our results for the winter season, the estimated coefficient of the dummy variable for location is significantly different from zero at the 5% level, indicating structural difference in production technology between the two sites. We have, therefore, estimated the production technologies separately for the two locations.

In this paper, we report the results for the rainy season at the Chandpur site only because they are statistically more precise.[3] The estimated parameters with their standard errors are given in Table 1. The standard errors have been computed using Klein's (1953:258) approximation formula. The critical *t* value for 73 degrees of freedom at the 5% level of significance is 2.00. The R^2 of the regression is 0.84.

[1] 15.5 takas (BDT) = US$1.

[2] Data on wages of skilled fisheries workers are from the statistical year book (Bangladesh, Bureau of Statistics 1979b:386).

[3] For a study of the Pabna fishery, utilizing a methodology appropriate to that site, see the paper by Mahbub Ullah (this volume, p. 211).

Table 1. Estimated parameters of the riverine fishing technology at Chandpur, Bangladesh, 1980.

Parameter	Estimate	Standard error	Computed t value
c	0.00004	0.00012	0.31320
a	0.89054	0.07765	11.46856
b_1	9.04171	1.93220	4.67950
b_2	-9.80648	2.34773	-4.1770
b_3	1.76477	1.32489	1.33201
b_{11}	-2.01330	0.45878	-4.38832
b_{12}	1.48364	0.39416	3.76403
b_{13}	0.52966	0.20220	2.61943
b_{22}	0.00013	0.37734	0.00036
b_{23}	-1.48377	0.40355	-3.67680
b_{33}	0.95411	0.33205	2.87342
d	-0.12988	0.17025	-0.76287

The F value of the regression is 55.26 with 7 and 73 degrees of freedom indicating that the joint hypothesis of all slope coefficients being zero is strongly rejected.

The estimate of a (0.89) is less than unity, indicating diminishing returns to extra fishing effort. However, the null hypothesis, a = 1, cannot be rejected in favour of the alternative, $a < 1$ at the 5% level of significance. The relevant computed t statistic is -1.41. The null hypothesis is, however, rejected in favour of the alternative at 10% level. Acceptance of the alternative hypothesis implies that the rental share of the stock should be 11% according to our estimate of a.

Our estimate of d, the coefficient of the dummy variable for net types, shows that there is no significant difference between the two kinds of nets.

The Cobb-Douglas specification of the technology is rejected. The relevant null hypothesis is $c_3 = c_4 = c_5 = 0$. The computed F statistic for this joint hypothesis is 9.85 and the critical F value for 3 and 73 degrees of freedom is 2.74 at the 5% level of significance. The rejection of the Cobb-Douglas representation indicates that the elasticities of substitution between the inputs are likely to be pairwise different and less than unity.

We now turn to an estimation of the three input elasticities of output at three observations, namely, those with the first quartile, median, and third quartile catch of fish. The estimated elasticities, obtained using relationship [7], are given in Table 2. These results indicate that the net is characterized by a negative marginal product. It appears that using fewer or smaller nets but more labour and boat tonnage is conducive to larger catch.

We have computed the elasticities of substitution for the median observation using definitions [9] and [10]. The estimated elasticities (Table 3) indicate that labour and boat are complements whereas labour and net and boat and net are substitutes. The elasticities are pairwise different; they also differ from unity. The extent of substitutability is, however, rather limited; the cross elasticities are all considerably less than unity. These elasticity interpretations are, of course, subject to the limitation that the estimated production function is not "well behaved." The marginal productivity of net is negative and its own elasticity of substitution is positive.

We have included only the labour, boat, and net inputs in the production function estimated above. The revenue incomes attributable to them are computed as:

$$R = PY - V - W - t \qquad [20]$$

Where W and t are defined as in equation [17] and V is the value per season of services of other inputs and is defined as:

$$V = V_1 + V_2 \text{ with } V_1 = \sum_i (Q_i/2N_i) \qquad [21]$$

Where i is floats, sinkers, bamboos, lanterns, flashlights, utensils, etc., and Q_i is the purchase price of the ith input and N_i is the expected life of the asset in years. For ease of computation with so many other inputs, we have excluded both the interest cost and the capital gain term in the user-cost calculation. Any possible error would be very small because most of the other inputs are of low durability (6–12 months) and the excluded terms are of opposite signs. The sum of the user costs of mast and anchors, V_2, is computed using [14]. The input shares, defined in [11], are now measured as:

$$s_i = P_i X_i / R, V_i \qquad [22]$$

The above shares, computed for the three observations with the first quartile, the median,

Table 2. Input elasticities and shares of catch in the riverine fishery of Chandpur, Bangladesh, 1980.

	Input elasticities			Input shares		
	Labour	Boat	Net	Labour	Boat	Net
First quartile	1.280	0.062	-0.452	0.750	-0.007	0.126
Median	-0.353	1.271	-0.027	0.798	0.002	0.039
Third quartile	0.485	0.716	-0.310	0.649	0.004	0.079

Table 3. Elasticities of substitution in the riverine fishery of Chandpur, Bangladesh, 1980.

Elasticity	Value
S_{11}	-1.216
S_{22}	-0.091
S_{33}	1.192
S_{12}	-0.334
S_{13}	0.185
S_{23}	0.077

and the third quartile catch, are also shown in Table 2. A comparison of these shares with the input elasticities shows that the shares of labour and net are larger than their elasticities whereas the reverse is true for boat. This implies that the earnings of labour and net exceed the value of their marginal products. On the other hand, the imputed cost of boat falls short of the value of its marginal product. This result indicates that the inputs of labour and net would have to be reduced and that of boat raised for optimality under a competitive system at the given structure of input prices.

It follows from the input share values that the shares of labour, boat, and net do not exhaust the revenue incomes defined in [20]. The residual shares, 0.13, 0.16, and 0.27 respectively for the three observations, accrue to the owner of boat and nets. If resources were properly allocated, these residuals would have been entirely part of the rental for the stock not paid to the society.

We computed the portions of gross revenues not paid or imputed to any of the fishing inputs (labour, boat, net, other inputs, or organizational services of the owner). The stock rents paid are respectively only 5.5, 7.1, and 3.8% of such amounts received by the three team leaders considered in Table 2. Our results, therefore, indicate that the society is being deprived of a considerable portion of rent for its scarce fish resources. According to our estimates, the rental for fish stock could have been as high as 11% of the gross revenues from fishing.

The rates of return (S/K) or profitability of investment in fishing for the three selected observations are presented in Table 4.

We have defined two rates of return. One is the rate of return actually obtained (S/K), as defined in [12], and the other is the true rate of return (S*/K) where S* is defined as the sum of earnings imputed to boat, net, and other fishing assets. Thus we have eliminated from S* the amount received by the owner of the fishing assets that should have been paid to society as rent. Both the rates of return are higher than 6%, the rate that we have chosen as the opportunity

Table 4. Rates of return on investment in the riverine fishery of Chandpur, Bangladesh, 1980.

	First quartile	Median	Third quartile
Rate of return obtained	0.650	0.540	0.639
True rate of return	0.348	0.140	0.161

cost of investment in fishing per season. The rate of return obtained, which is about two to four times the true rate of return is, however, roughly equal to the biannual rate of interest (60%) typically charged in noninstitutional money lending. If the latter rate is chosen as the opportunity cost of investment in fishing, the true rate of return indicates that there has been over investment in fishing. This has occurred because the wrong "signal" has been given by the much inflated rate of return obtained. The latter contains an amount that is actually rental for the fish stock rather than return to fishing investment.

Finally, our study reveals that accidental loss of nets while fishing is a rather widespread phenomenon in riverine fishing. Among the 81 team leaders interviewed in the Chandpur fishery 10 persons reported damage to or loss of boats and 71 incurred damage to or loss of nets. On an average, the latter amounted to 36% of the value of nets. Damage to or loss of nets is a matter of great concern to the fishermen because the net has to be repaired or replaced immediately if the valuable fishing time is to be used. One approach to removing this insecurity is the introduction of an insurance scheme for nets in riverine fishing. This would contribute to a larger catch of fish by encouraging quick repair to or replacement of nets.

Conclusions and Policy Implications

Although two sites — Chandpur and Pabna — that differ in several respects were selected for estimation of their production technologies, we have presented only results for Chandpur during the rainy season. The results indicate that there is no significant difference between catch by the two types of nets, drift and seine nets. The government can, therefore, promote the use of the less expensive drift nets.

The returns to effort are likely to be diminishing and a doubling of effort would lead to only an 89% rise in catch of fish because the stock of fish is fixed. An implication of this result is that the rental for fish stock would equal 11% of the gross revenues from fishing. At present, the majority of this amount is received by the owner of the fishing assets and the share of the rental accruing to the government through the auction of fisheries is very low. There is considerable scope for raising the rental for the fish resources.

The fishing inputs are at present misallocated. To achieve optimal resource allocation at the current prices, the inputs of labour and net should be reduced and that of boat raised. The marginal productivity of net is indeed negative at its present level of use.

Fishing appears to be a profitable business to invest in when its rate of return is compared to the institutional rate of interest (6%). We chose this rather low opportunity cost on the assumption that the best feasible alternative to investment in fishing at our study site is to become a labour fisherman and save the investible funds in a bank. If, however, the funds could be invested in noninstitutional money lending, the opportunity cost would have been as high as 60%. At this opportunity cost, there has been overinvestment in fishing because of a "wrong signal" given by the rate of return obtained by the owners of fishing assets. These returns are inflated because they include a major portion of rental due, but not paid, to the society. An increase in rental accruing to the government for the fish stock should check the overinvestment in fishing.

Accidental loss of net is a rather disturbing phenomenon to the fisherman. The introduction of an insurance scheme for nets is likely to augment the catch of fish by encouraging quick repair or replacement of nets.

Production Technology of Small-Scale Fisheries in Peninsular Malaysia

L.J. Fredericks and Sulochana Nair[1]

To assess the efficiency of the production technologies or gears used by a sample of small-scale fishing households in Peninsular Malaysia, production function analysis was used. The sample included 261 fishing households using five different gear types (trawling, handlines, drift nets, shellfish collection, and longlines). Because these fishing households were distributed in Kuala Trengganu, Port Weld, and Pantai Remis, it was necessary to consider the condition of the fishery resources in the areas where the fishermen fished for the 2 sample months for which data was collected. Thus, the fishery production function combined both biological aspects (the condition of the fishery resource) and the technology employed to catch fish.

Fishery Production Function

The general form of the production function specifies catch (Y) as a function of effort (E), which is a composite index of fishing inputs:

$$Y = f(E) \qquad [1]$$

Effort itself can be disaggregated into the factors of production used to produce the catch, that is, labour, capital, and time spent fishing, or more specifically boat, gear, fuel, labour, and management ability. The boat may be represented by its length in feet (E_1), its gross tonnage (E_2), or the horsepower of its engine (E_3); gear by the length (E_4) or mesh size (E_5); fuel by the corresponding expenditure (E_6); labour may be measured in terms of man-hours of fishing time (E_7); and management ability represented by the age of the operator (E_8) and his fishing experience. Then, equation [1] may be rewritten as:

$$Y = f_1(E_1, E_2, ..., E_8, E_9) \qquad [2]$$

Where Y represents the value rather than the volume of the catch, which in most cases is multispecies. The use of the value instead of the volume facilitates aggregation of catch over the component species, but introduces price as another source of variability across locations. Thus, in using the catch value as our independent variable, we assume that prices do not vary significantly between locations at the same point in time; this, in our case, is not too unrealistic an assumption.

The Cobb-Douglas production function was chosen as the specific functional form of the underlying relationship between the value of catch and its explanatory variables:

$$Y = AE_1^{a_1}E_2^{a_2} ... E_8^{a_8}E_9^{a_9} \qquad [3]$$

which, in log-linear form, may be written as:

$$lnY = lnA + a_1lnE_1 + a_2lnE_2 ... + a_8lnE_8 + a_9lnE_9 + \mu \qquad [4]$$

Where μ is an error term with appropriate properties. Ordinary least-squares (OLS) analysis may be used to estimate equation [4] for the different gear types in the different locations and, given the properties of the Cobb-Douglas production function, it is possible to derive the traits of the production technology of each gear.

To take into account the effects of the different gears used and the different locations fished, dummy variables were introduced into the production function. Furthermore, an additional explanatory variable was introduced related to the age and experience of the fishermen as a proxy for his or her management ability.

[1]We are grateful to the Computer Centre at the University of Malaya for responding to our request for a quick analysis of our data for this chapter. We also wish to express our appreciation to Dr T. Panayotou for his valuable comments and suggestions.

Production function analysis by gear and location

In this analysis, production functions for each gear in each location were first estimated and, later, an aggregate production function was derived including dummy variables for location (L) and gear (G).

To assess the impact of the independent variables on fishing output (in value terms), regression equations of the general form [4] were estimated for each of the gears in the three locations. Because of multicolinearity among the length, tonnage, and horsepower of the boat as well as between age and experience, only one variable was selected as a proxy for the boat and one for management, the selection criterion being the variable with the highest correlation with the dependent variable. Mesh size and gear length were also included as proxies for the gear in the cases of trawl nets and drift nets.

The results of the estimation of production functions for individual gears are shown in Table 1. The R^2 value ranges between 0.6 and 0.8 for trawl nets in all three locations and for longlines in Pantai Remis whereas it is relatively low for handlines and shellfish collectors. Based on the adjusted R^2 ($\bar{R}^2$), we may conclude that we have been able to explain between 60 and 70% of all variation in the value of catch among fishermen using trawl nets in all three locations and longlines in Pantai Remis. In contrast, the explanatory power of our model was relatively weak in the cases of handlines, drift nets, and shellfish collectors.

The coefficient for fuel was statistically significant at the 0.05 level for all gears except shellfish collection; in fact, this is the only significant variable common to nearly all gears in the sample. The coefficient for gear length was significant only for trawl nets in Port Weld and that for fishing time was significant for handlines in Kuala Trengganu and trawl nets in Pantai Remis. The coefficients for all other variables were not statistically significant.

The overall F ratios were significant for trawl nets in all three locations, for handlines in Kuala

Table 1. Estimated production functions by gear and location, Peninsular Malaysia, 1979.

	Kuala Trengganu (L_1)		Port Weld (L_2)		Pantai Remis[a] (L_3)		
	Trawl nets (G_1)	Handlines (G_2)	Trawl nets (G_1)	Drift nets (G_3)	Shellfish collection (G_4)	Trawl nets (G_1)	Longlines (G_5)
Variables							
Tonnage (E_1)	–	–	–	–	0.2468 (2.409)	–	–
Fuel (E_2)	0.6623* (72.493)[b]	0.2710* (18.096)	0.3368* (16.474)	0.3331* (6.024)	–	0.3983* (17.552)	0.5503* (16.004)
Gear length (E_3)	0.0779 (0.551)	–	0.4297* (6.956)	0.1000 (0.214)	–	0.3733 (2.693)	–
Mesh size (E_4)	0.0749 (1.615)	–	–	0.0520 (0.139)	–	−0.3462 (0.697)	–
Fishing time (E_5)	0.2140 (1.453)	0.2936* (7.374)	–	0.0341 (0.019)	0.2186 (0.151)	0.0162* (5.584)	1.1453 (0.797)
Age (E_6)	−0.1714 (2.586)	–	−0.0135 (0.014)	–	–	0.0268 (0.010)	−0.9809 (3.836)
Experience (E_7)	–	−0.0041 (0.015)	–	−0.2228 (1.449)	0.1848 (4.055)	–	–
Intercept	3.6940	5.0946	4.0587	5.2542	4.8975	0.3093	5.0170
Statistics							
R^2	0.6983	0.3108	0.6359	0.4654	0.3693	0.7278	0.7928
$\bar{R}^2$	0.6623	0.2843	0.6007	0.2427	0.2342	0.6478	0.7040
S	0.1807	0.1218	0.2337	0.2598	0.2126	0.3331	0.4212
F	19.4387*	11.7269*	18.0484*	2.0898	2.7328	9.0923*	8.9283*
df[c]	53	83	37	18	18	24	11

Note: *indicates variables that are significant at the 0.05% level.
[a]The number of drift nets (6 units) in Pantai Remis was too small for econometric estimation of production functions.
[b]Values in parentheses are the F ratios for the corresponding regression coefficients.
[c]df = degrees of freedom.

Trengganu, and for longlines in Pantai Remis, but not for drift nets and shellfish in Port Weld.

Differences in resource availability and gear technology

Aggregate production functions of individual gears for all locations combined were estimated to test the significance of the characteristics of fishing grounds. It is assumed that fishing effort is homogeneous across locations and that the major differences among them affecting the catch of a common gear are the availability of and accessibility to fisheries resources. The differences in fishing grounds and locations are represented by dummy variables with the sample from Kuala Trengganu taken as the reference (base) for trawl nets and that from Pantai Remis as the reference for drift nets and shellfish collection. Regression equations were estimated for trawl nets with dummy variable $L_2 = 1$ if the sample is drawn from Port Weld ($L_2 = 0$ if otherwise) and $L_3 = 1$ if the sample is taken from Pantai Remis ($L_3 = 0$ if otherwise). R^2 and $\bar{R}^2$ improved considerably when the dummy variables for location were included in the regression equation (Table 2). For trawl nets, the coefficient for fuel remains significant whereas that for the dummy variable for location-specific resource availability was not significant. Although this might be interpreted as meaning that there is no statistically significant difference in resource availability among the three locations as far as trawl nets are concerned, the improvement in the explanatory power of the model (as reflected in the increase in R^2) implies some latent differences among locations.

When aggregate production functions are estimated for drift nets and shellfish operators with the Pantai Remis sample as the base, the fuel and experience coefficients are statistically significant for drift nets. The dummy variable for location is significant and negative thus indicating that resources are less abundant at Port Weld than at Pantai Remis. For shellfish operators, the experience coefficient is statistically significant but that for the dummy for location is not significant, thus showing that the availability of shellfish resources does not vary between Pantai Remis and Port Weld.

Aggregate production functions

To account for the effects of different gears on fishing output, aggregate production functions combining various gears were also estimated for each of the three locations. The trawl nets were used as the base with dummy variables $G_2 = 1$ for handlines, $G_3 = 1$ for drift nets, $G_4 = 1$ for shellfish, and $G_5 = 1$ for longlines. The assumption underlying this estimation is that given a certain resource base, differences in output reflect differences in the quantity of inputs used as well as differences in the type of gear employed.

Finally, a single aggregate production function using two sets of dummy variables, one for the different locations and the other for the different gears, was estimated for the whole sample of 261 observations (Table 3). Taking individual locations first; in Kuala Trengganu, the coefficients for fuel, fisherman's age, and the gear dummy for handlines are statistically significant. Fuel makes a positive contribution to output but age is negatively related to output. The positive coefficient for handlines indicates that this gear in Kuala Trengganu is more efficient than trawl nets in the same location. In Port Weld, fuel costs and gear length are significant explanatory variables; among gear types,

Table 2. Production function analysis using location as dummy with gear type constant, Peninsular Malaysia, 1979.

	Trawl nets (G_1)	Drift nets (G_3)	Shellfish collection (G_4)
Variables			
Fuel (E_2)	0.5032*	0.3392*	–
	(112.817)[a]	(8.801)	
Tonnage (E_1)	–	0.1113	–0.1130
		(0.500)	(0.315)
Gear length (E_3)	0.1200	–0.1154	–
	(2.698)	(1.623)	
Mesh size (E_4)	0.0447	0.1331	–
	(0.374)	(1.021)	
Fishing time (E_5)	0.2642	0.0785	–0.5075
	(2.147)	(0.088)	(1.482)
Experience (E_7)	0.0385	–0.2113*	0.3359*
	(1.000)	(4.828)	(10.569)
Location L_2	–0.2412	–0.3801*	–0.3110
	(1.426)	(6.032)	(2.287)
Location L_3	0.0870	–	–
	(0.230)		
Intercept	3.5735	5.9376	7.3183
Statistics			
R^2	0.8550	0.7615	0.3798
$\bar{R}^2$	0.8446	0.6422	0.2617
S	0.2480	0.2410	0.4229
F	82.5572	6.3858	3.2154
n	114	24	29

Note: *denotes variables that are significant at the 0.05% level.
[a]Values in parentheses are the *F* ratios for the corresponding regression coefficients.

Table 3. *Aggregate production functions, Peninsular Malaysia, 1979.*

	Kuala Trengganu	Port Weld	Pantai Remis	All
Variables				
Fuel (E_2)	0.5324*	0.3281*	0.5170*	1.3199*
	(125.446)[a]	(27.251)	(17.439)	(305.838)
Tonnage (E_1)	–	–	–	1.0824*
				(124.209)
Gear length (E_3)	–	0.4002*	0.1782	2.1888*
		(11.840)	(1.169)	(151.516)
Mesh size (E_4)	–	-0.0645	-0.9467	-3.8376*
		(0.495)	(3.912)	(145.769)
Fishing time (E_5)	0.1555	-0.1100	-0.7665	3.6578*
	(2.651)	(0.386)	(1.772)	(133.113)
Age (E_6)	-0.1291*	–	–	–
	(5.111)			
Experience (E_7)	–	0.0814	0.2981*	–
		(3.022)	(5.063)	
Handlines (G_2)	0.1311*	–	–	5.5368*
	(8.344)			(143.967)
Drift net (G_3)	–	-0.3846*	0.3319	-0.1937*
		(7.523)	(1.168)	(8.280)
Shellfish collection (G_4)	–	0.8355*	-0.2635	3.4743*
		(6.946)	(0.878)	(129.29)
Longlines (G_5)	–	–	–	–
			(1.169)	(130.651)
Location L_2	–	–	–	-2.2657*
				(181.057)
Intercept	4.4622	4.2706	6.3522	12.9606
Statistics				
R^2	0.6109	0.5137	0.6433	0.8971
$\bar{R}^2$	0.5986	0.4587	0.5006	0.8897
S	0.1555	0.2413	0.4680	0.1935
F	49.8418	9.3546	4.5091	121.2435
n	48	73	52	261

Note: *denotes variables that are significant at the 0.05% level.
[a]Values in parentheses are the *F* ratios for the corresponding regression coefficients.

drift nets are least efficient, shellfish collection is most efficient, and trawl nets are intermediate. For Pantai Remis, fuel and fishermen's experience are significant in explaining catch. Among the gears used in this location, no significant productivity differences are indicated. For all the gears taken in the aggregate, variations in fuel costs, boat tonnage, gear length, mesh size, and fishing time explain about 90% of the variation in output produced. Compared to the trawlers in Kuala Trengganu, handlines, shellfish collection, and longlines are more efficient in catching fish whereas drift nets are less efficient. Locationally, Port Weld waters are less resource rich as compared to the sea off Kuala Trengganu.

Returns to Scale and Efficiency in Input Use

The production function estimation yields information on returns to scale for the various gears. Returns to scale can be increasing, decreasing, or constant depending on the ratios of inputs to output. In the Cobb-Douglas formulation, returns to scale (RTS) are given by the sum of the input coefficients:

$$RTS = a_1 + a_2 + \ldots + a_n \qquad [5]$$

The returns to scale and marginal products of inputs are given in Table 4. Increasing returns to scale are only found in the trawl fisheries of Kuala Trengganu and the Pantai Remis long-

Table 4. Marginal products[a] and returns to scale by gear and location, Peninsular Malaysia, 1979.

Inputs	Kuala Trengganu (L_1) Trawl nets (G_1)	Kuala Trengganu (L_1) Handlines (G_2)	Port Weld (L_2) Trawl nets (G_1)	Port Weld (L_2) Drift nets (G_3)	Pantai Remis (L_3) Shellfish collection (G_4)	Pantai Remis (L_3) Trawl nets (G_1)	Pantai Remis (L_3) Longlines (G_5)
Fuel (E_2)	4.02	2.3	4.7	3.9	–	4.8	7.1
Tonnage (E_1)	–	–	–	–	3.1	–	–
Gear length (E_3)	61.5	–	19.0	1.9	–	29.7	–
Mesh size (E_4)	52.5	–	–	9.1	–	–263.6	–
Fishing time (E_5)	18.8	26.5	–	1.2	57.3	1.2	93.6
Returns to scale[b]	1.0291	0.5645	0.7665	0.5193	0.4654	0.4416	1.6956

[a]The marginal products (MP) are obtained using the following formula: $MP = \Delta Q/\Delta E_i = (\Delta Q/\Delta E)a_i = a_i AP_i$
[b]The returns to scale (RTS) are calculated as: $RTS = a_1 + a_2 + ... + a_7$ where a_i = coefficients of inputs.

Table 5. Efficiency in fuel and labour input use, Peninsular Malaysia, 1979.

Input	Kuala Trengganu Trawl nets VMP	Kuala Trengganu Trawl nets P_i	Kuala Trengganu Handlines VMP	Kuala Trengganu Handlines P_i	Port Weld Trawl nets VMP	Port Weld Trawl nets P_i	Port Weld Drift nets VMP	Port Weld Drift nets P_i	Pantai Remis Trawl nets VMP	Pantai Remis Trawl nets P_i	Pantai Remis Longlines VMP	Pantai Remis Longlines P_i
Fuel	2.6	1.8	1.3	1.8	21.0	1.6	12.1	1.7	17.3	1.5	30.5	4.9
Labour	11.3	8.4	13.2	8.4	–	–	11.5	8.4	4.3	8.4	402.5	8.4

lines. For all other gears, decreasing returns to scale were obtained. These results indicate that doubling all fishing inputs would more than double output in Kuala Trengganu trawlers and Pantai Remis longlines and less than double output in all other gears.

To estimate the degree of efficiency of input use, an attempt was made to relate the value of the marginal products of inputs (VMP_i) to their price (P_i). However, because of the difficulty of estimating market prices for most of the inputs, the efficiency of only fuel and labour use is analyzed. (The price of labour is estimated using the wage rates of the Industrial and Manual Group of 210 MYR/month.)[2] As seen in Table 5, the VMP of fuel exceeds fuel price (P_i) for all gears except handlines in Kuala Trengganu, thus indicating that more fuel can be used by these gears. For handlines, however, excessive fuel is being used and should be decreased. When the VMP of labour is related to its price, it is observed that labour inputs can be increased for all gears in the sample except trawlers in Pantai Remis where the VMP : P_i ratio is less than one. For most types of gears and locations, however, fishermen are underusing both inputs — presumably because of capital constraints.

Summary and Conclusion

In analyzing the production technology of the various gears used in the sample, Cobb-Douglas production functions were used relating the value of output to various variables acting as proxies for capital (boat length, boat tonnage, engine horsepower, gear length, mesh size, and fuel), labour (fishing time), and management (age and experience of fishing operator). The actual choice of explanatory variables depended on the correlation of these variables with the dependent variable (output) to avoid multicolinearity. Also, to investigate possible differences in the catching power of the various fishing gears used, dummy variables were employed. A similar procedure was undertaken to analyze the effect of location on output on the assumption that fishery resources vary in availability and accessibility across locations. In particular, one would expect a difference in resource abundance between the East and West Coasts.

For most types of gears and locations, we were able to identify the factors accounting for over 60% of the observed variation in the value of the catch. Fuel turned out to be the most significant explanatory variable across gears and locations, and as such it can be considered as the limiting factor constraining catch. It should be noted, however, that fuel might also be a proxy for fishing time and horsepower. In a few cases, such as the Kuala Trengganu handlines and Port Weld trawls, fishing time measured in terms of man-days of labour was also a significant explanatory variable.

An analysis of individual gears for all three locations taken together revealed that for trawl nets, no statistically significant differences in

[2]2.31 ringgits (MYR) = US$1.

resources exist among Kuala Trengganu, Port Weld, and Pantai Remis. For drift nets, significant resource differences exist between Pantai Remis and Port Weld (the only locations in which drift nets were used) and shellfish collection was undertaken under basically similar resource conditions in the two West Coast sites surveyed. Given the widely held view that West Coast fishery resources are generally overexploited, this finding naturally raises a question that requires further investigation.

The aggregate production function study by individual location revealed once again the significance of fuel costs in explaining the output of the various gears. In addition, the following results were obtained. In Kuala Trengganu, younger fishermen were found to be technically more efficient than older ones, and handlines more productive than trawl nets. In Port Weld, in addition to fuel costs, gear length was also significant but drift nets were clearly less efficient than shellfish collection, which was, in turn, less efficient than trawl nets. In Pantai Remis, fuel and experience were the significant factors explaining catch; however, among the gears used here, no significant differences in efficiency were found. For all gears taken together, fuel cost, tonnage, gear length, mesh size, and fishing time explain as much as 90% of all variations in catch among fishermen. Com-

pared with the Kuala Trengganu trawlers, handlines, shellfish collection, and longlines were more efficient whereas drift nets were less efficient. In terms of locational differences in marine resource conditions, Port Weld was found to be less rich than Kuala Trengganu, but there was no significant difference between the latter and Pantai Remis.

Of all the gears sampled, only the Kuala Trengganu trawl nets and Pantai Remis longlines showed increasing returns to scale; all other gear groups exhibited decreasing returns to scale. Only for two inputs, fuel and labour, could the price efficiency be evaluated as it was difficult to obtain prices of the other inputs. With the exception of Kuala Trengganu handlines, the value of the marginal product of fuel was higher than the price of fuel, clearly indicating that the use of fuel is below the economic optimum and that profits could be increased by using more fuel for longer or further trips to sea bringing in additional catch whose value would exceed the cost of obtaining it. Labour was also below its economic optimum for all gear groups except for the Pantai Remis trawl nets. Profits to the boat owner could increase either by employing a larger crew or by increasing the fishing time of the existing crew or a combination of the two. This is particularly important in the light of the surplus labour, in the form of unemployment and underemployment, found in Malaysian fishing communities. Although it must be recognized that boat owners may be operating under costs constraints that prevent them from satisfying the marginal conditions, further research is needed before a case can be made in favour of government subsidies.

Cost Structure and Profitability

Cost Structure and Profitability of Small-Scale Fishing Operations: A Conceptual Framework

Theodore Panayotou

Having described the general socioeconomic conditions and relative income levels of small-scale fishing households in the first section of this volume, it would be useful to study more closely the cost structure and profitability of small-scale fishing operations because these account for the major part of a fishing household's total income. The nine specific questions to which answers are sought are:

- What are the relative capital and labour intensities of various fishing technologies in different locations?
- How sensitive is the cost structure of various types of gear to fuel price increases?
- How much of the total costs of different types of gear are independent of the day-to-day operations?
- What is the degree of dependence on credit and at what cost?
- How are the total revenues divided between the boat owner and the crew for different types of gear and in different locations?
- Which types of gear and which fishing grounds are on the average more profitable?
- Are relatively larger vessels on the average more profitable than smaller ones?
- Do the prices of fish and fishing inputs differ substantially among vessel sizes and among locations to the extent that they have an effect on profitability? and
- What other factors besides vessel size, gear type, location, and prices have a bearing on profits?

The basic unit of analysis here is the boat in the case of boat owner-operators and the individual labourer in the case of the crew. Fishing operations may be distinguished according to location or fishing ground and according to technology or type of fishing gear. It is important to group fishing units according to fishing gear and fishing ground because of the apparent "immobility" between gear types and between fishing grounds. For historical as well as economic reasons, fishermen are locked into particular types of technology and locations of operation from which it is not easy to escape, even if other types of gear and other locations are more profitable. Another such fixed factor is the size of the vessel, which determines, to a large extent, the fishing range and catching power of the individual fishing unit. Vessel size may be represented by length, tonnage, horsepower, or current value of fishing assets.

Of the nine questions raised, the first four can be answered by describing the cost structure of fishing operations whereas the last four require analysis of the profitability of fishing. The fifth question concerns both the cost structure and the profitability of fishing because fishing labour is often paid a share of the value of the catch rather than a fixed wage. Thus, we may divide the analysis into three related parts: cost structure, sharing system, and profitability.

Cost Structure

Fishing costs should be distinguished as fixed (FC) and variable costs (VC). Fixed costs are incurred whether the fishing unit operates or not because they relate to "sunk" capital investment that cannot be retrieved at short notice without undue loss. Fixed costs consist mainly of the cost of depreciation (combined natural decay and obsolescence) of the fishing assets and the interest payments on borrowed capital used for the purchase of these assets (and any other related use). The opportunity cost (interest forgone) of owned capital invested in fishing assets should also be included as part of the fixed cost. To calculate depreciation (d), we need the purchase price or capital cost (P) of such fishing assets as boat, engine, and in some cases nets, their economic life (L), and their scrap or salvage value (S). Using the straight-line depreciation method, we can calculate:

$$d = (P - S)/L \qquad [1]$$

As the opportunity cost of own capital, we may use the secure rate of return from the next best use of own capital (e.g., interest on bank savings or on government bonds). Thus we have:

$$FC = d + r_1D + r_2K \qquad [2]$$

where d is depreciation, r_1 is interest rate on borrowed funds, D is total fishing-related debt, r_2 is opportunity rate of return, and K is own capital (current value of assets).

Operating or variable costs (VC) are defined as the sum of the costs of all inputs that are incurred only when the fishing unit operates. We may distinguish three kinds of variable costs:

- Running costs, such as fuel, oil, ice, nets, and maintenance costs, all of which depend on fishing effort;
- Labour costs, such as fixed wages and food, which depend on effort, and crew shares and bonuses, which depend on catch; and
- Shore costs, such as landing, packaging, and marketing fees, which depend also on catch.

Quantitatively, the most important costs in the case of nonmotorized boats are those spent on labour and nets. Often all or part of the crew is drawn from the fisherman's own family and, although no direct payments are involved, the opportunity cost of family labour should be estimated and imputed. In the case of motorized vessels, fuel is also an important cost item, often accounting for over 30% of variable costs. The net may be a variable input depending on the material of which it is made, the type of gear for which it is used, and our definition of the short-run. Other inputs such as ice, oil, and maintenance account for a relatively small percentage of total variable costs and may be aggregated into "other inputs" unless we wish to focus particularly on the effect of using more ice or better maintenance on the value and quantity of catch respectively. Thus, a possible classification of variable costs is:

$$\text{Variable costs} = \text{labour cost} + \text{fuel cost} + \text{other input costs} + \text{opportunity cost of family labour} \quad [3]$$

By defining the components of total cost, we have now obtained two useful cost comparisons:

- Between fixed and variable costs, the first of which are independent of the day-to-day operations whereas the second should be completely covered if operations are to continue over the short run — for long-run viability, both should be covered by earnings; and
- Between cash costs and imputed costs, the first of which are paid in cash on a regular basis and therefore have to correspond to the cash-flow situation of the fishing unit whereas the second are implicit and hence not a constraint to the short-term operations of the fishing unit.

Imputed costs may be further subdivided into depreciation cost and the opportunity cost of own inputs. Depreciation cost is basically a fund reserved for replacement of obsolete fishing assets and, therefore, for fishing operations to continue in the long-run, earnings should be high enough to cover depreciation costs as well as cash costs. The opportunity costs of owned inputs are basically payments to the owned factors of production (family labour, capital, and management) and, therefore, they constitute consumable household income. Thus total cost may be rewritten in three alternative forms:

$$\begin{aligned}\text{Total costs} &= \text{fixed costs} + \text{variable costs}\\ &= \text{cash costs} + \text{imputed costs}\\ &= \text{cash costs} + \text{depreciation} + \text{opportunity cost of owned inputs}\end{aligned} \quad [4]$$

Once the various costs have been calculated, the cost structure may be described by expressing the various costs as a percentage of total costs and comparing these percentages between locations, gear types, and vessel sizes. For instance, one may study the relative importance of labour, fuel, and fixed and imputed costs. The proportion of labour costs to the total cost is an indication of the labour intensity of the particular type of technology and the proportion of fixed to total costs is an indication of the capital intensity. Moreover, the relative importance of fixed costs vis-à-vis the variable costs indicates the degree of inflexibility or immobility of the fishing operations carried out by different types of gear. Fuel as a proportion of total costs may serve as an indicator of the vulnerability of fishing to the rising fuel prices — in the light of expected increases in fuel prices, governments may want to discourage fuel-intensive types of gear. Debt as an absolute amount, as well as a proportion of the total capital of the fishing unit, is an indicator of the unit's dependence on credit. However, the interest on borrowed capital is not the only cost of credit because fishermen often borrow from traders and middlemen with no explicit interest rate, and the interest charges are hidden in the obligation to sell the catch to the particular trader at lower than market prices (see section on profitability). Input prices may also include a hidden interest rate when inputs are purchased on credit or from one's moneylenders. To find the true cost of borrowing in these cases, it is necessary to compare input and output prices between borrowers and nonborrowers and regard as interest charges any difference that cannot be explained by other factors.

The Sharing System

Up to this point, we have treated labour costs in the same way as any other variable input. This is appropriate when the crew is hired on a fixed wage rate and, therefore, total labour cost is the product of the wage rate and the number of man-days worked. However, it is common for crew to be paid a share of the value of the catch in addition to (or instead of) the fixed wage rate. Sharing systems vary widely, ranging from a few kilograms of fish for own consumption to as much as 65–75% of the value of the catch after running costs have been paid. The way the catch is valued also varies. For instance, in Peninsular Malaysia, it is reported that nonsea-going boat owners use preagreed fixed prices for valuing the catch for sharing purposes whereas sea-going operators use current market prices. In Thailand, it is common to pay the crew partly in terms of a fixed wage rate and partly in terms of shares.

These various systems of labour remuneration differ in at least one important respect: the amount of risk borne by the two factors of production, capital and labour. Under the fixed wage system, all risk (and windfall profits) arising from both the vagaries of nature and market are borne (enjoyed) by the owners of the fishing assets and the crew is assured of a steady income not lower than the going wage rate in similar activities. Under a sharing system based on market fish prices, the crew bears part of both types of risk (low catch and low price) and shares in windfalls from both sources (high catch and high price). Under a sharing system based on fixed fish prices, the crew shares only in the risk and windfall profit arising from variations in the catch but not from changes in market conditions. Finally, under the mixed system, a smaller share of both risks is assumed by the crew.

The sharing system also has implications for the comparison of crew earnings among different types of gears and locations. Crew paid on a share basis ought to have higher earnings (part of which is a premium for risk-taking) than crew paid on fixed-salary basis. Other things being equal, those paid a share of revenues minus running costs would be expected to have the most variable, and the highest on the average, earnings. Thus, a comparison of their earnings with what appears to be their opportunity cost (wage rate of hired workers of similar skills) is not appropriate without making the necessary adjustments for risk-taking. In an open-access fishery and with elastic labour supply, however, crew earnings, although not necessarily equal, will bear some relationship to labour's opportunity costs.

A third implication of the sharing system relates to the profit-maximizing behaviour of the boat owner. Under a fixed wage system, he will add to the crew up to the point where the value of the marginal product of the crew just equals the wage rate. Under a share system, the boat owner adds to the crew up to the point where the value of the marginal product equals the marginal cost of the last crew member to be added (i.e., his share in the increased proceeds plus any increases in the shares of others as a result of the addition to the crew). The sharing system also has implications for income distribution, especially if the supply of labour is inelastic or there are barriers to entry, in which case the crew enjoys a share of the resource rents generated from the fishery. In the absence of barriers to entry into the fishery, however, these rents and hence the crew's respective shares are expected to be dissipated in the long run through excessive effort and consequent overfishing. A comparison of crew earnings between different gear types or locations with the same share system or same opportunity cost of labour may help identify the particular types of gear and locations that are still capable of yielding resource rents.

Profitability

In this section, the emphasis is on the profitability of fishing operations from the point of view of the boat owner-operator. He/she is in the business of fishing for the purpose of earning a living, and to do so gross receipts must at least exceed operating or variable costs. However, unless such surplus, known as operating or gross profit, is sufficient to cover the depreciation (i.e., to provide for the eventual replacement of the fishing assets), he/she cannot stay in business beyond the economic life of the current fishing assets. In fact, he/she would not want to stay in fishing for too long if the surplus over operating costs is not large enough to cover, in addition to depreciation, the interest on any loans as well as earn a return on the owned capital as high as he/she can get from some other activity. Thus, we have two concepts of profit — operating or gross profit and net profit. Gross profit is defined as the difference between total revenues (TR) and operating or variable cost (VC) or:

$$\Pi_{gross} = TR - VC \qquad [5]$$

A fishing unit is expected to continue operating as long as a positive gross profit is earned, i.e., as long as operating costs are covered and some surplus is left to cover some of the fixed costs that must be paid whether the fishing unit operates or not. However, a situation in which not all fixed costs are covered is not tenable in the long run: operations will be terminated when the economic life of the current assets expires or when an "acceptable" resale value can be obtained, whichever comes first. Thus, we have the concept of net profit, defined as the difference between total revenues and total costs (TC):

$$\Pi_{net} = TR - TC \qquad [6]$$

Nonnegative net profit is a prerequisite for the long-term viability of a fishing unit. Because of the long life of fishing vessels and the lack of an organized resale market, on the one hand, and because of the nature of fishing as a way of life coupled with the geographic isolation of many fishing communities, on the other, it is not uncommon to encounter fishing units operating at a loss for several years. In fact, the fate of many small-scale fishermen to live in poverty is the result of the asymmetry between entry into and exit from the fishery. It appears that many entered the fishery when profits were high and the cost of entry relatively low but few left when profits declined because there were too many fishermen. Those who stay in fishing attempt to maintain their position by increasing their investment in fishing assets and thereby lock themselves more deeply into the fishery. Certains types of gear at certain locations may continue to be profitable but others may be operating at a loss. Liquidation of fishing assets may involve an even greater loss (perceived or actual) and conversion to other technologies or extension to other locations may involve substantial investment that is often beyond the capability of small-scale fishermen. For this reason, it is important to calculate and compare the profitability between different types of gear, sizes of vessels, and locations.

Fishing units with negative gross profits are clearly not viable, especially if this situation has continued for some time. These units should be the focus of urgent government assistance either to upgrade their fishing operations or to terminate them altogether. Fishing units with positive operating profits but negative net profits are either undergoing temporary problems (e.g., a bad fishing season) or simply living off their capital. In the latter case, assistance to switch to more profitable gear or richer fishing grounds (if such exist) will be necessary at the end of the economic life of current fishing assets. For this reason, the most profitable types of gears and locations must be known. Alternatively, if underfished grounds do not exist, the government may utilize the intervening time — between the present and the obsolescence of fishing assets — to develop nonfishing employment opportunities for fishermen to move into.

In addition to the absolute magnitudes of gross and net profit, profitability may be expressed in terms of the return to capital, which can be compared to the going rate of return from investments in activities of comparable risk. To obtain the return to capital, we deduct from net profit the opportunity cost of management (earnings of hired operator of similar skill), add the opportunity cost of own capital and the interest on borrowed funds, and divide the result by the total value of the assets. Those fishing units that earn a return to capital larger than or equal to the return on investments of comparable risk are considered to be profitable. Similarly, the return to 1 man-day of management or of crew labour may be obtained and compared to the respective wage rate.

Other indicators of profitability from the point of view of a subsistence household are gross and net family income. Gross family income, defined as total revenues minus cash cost (or operating profit plus imputed costs), indicates the amount of fishing income available to the household for consumption over the short run (i.e., it is not sustainable because it makes no provision for replacement of the fishing assets). By subtracting depreciation from gross family income, we obtain net family income, which is equal to net profit plus opportunity cost of own inputs. As such, net income consists of returns to own factors of production (and rents, if any) and it is consumable without impairment of the household's future earning capacity.

Pure Profits and Resource Rents

If some fishermen earn positive net profits, it is useful to examine to what extent these profits are due to:

- Higher risk-taking (i.e., they include a risk premium);
- Superior management and skills on the part of the owner-operator (rents of ability);
- Prompt adoption of a new technology (quasi-rents);
- Monopolistic power (monopoly or monopsony rents); or
- Access to superior fishing grounds (resource rents).

Risk may be taken into account by adjusting the opportunity cost of capital upward (and net profit downward) to allow for a "reasonable" risk

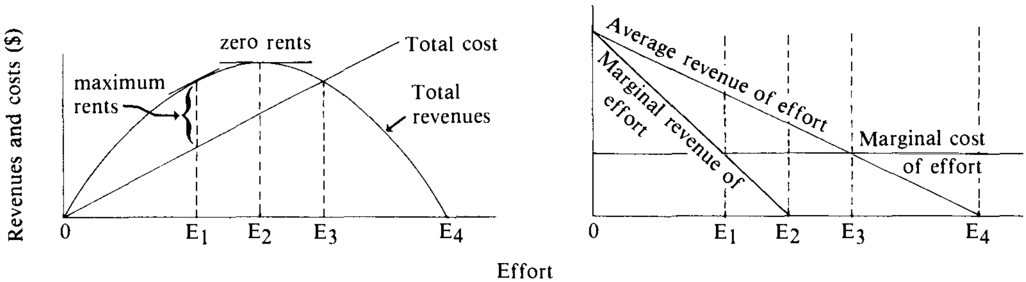

Fig. 1. Resource rents in an open-access fishery.

premium. To arrive at the concept of pure profit, we must also deduct the opportunity costs of management over and above the opportunity cost of the owner-operator's labour. Any remaining profit (pure profit) consists of rents, the source of which is difficult to ascertain. It is unlikely, however, that small-scale fishermen earn any monopoly rents from the sale of their catch or any monopsony rents from the purchase of their inputs because of their large numbers and the lack of effective fishermen's organization. (On the contrary, it is often alleged that they suffer from the monopolistic and monopsonistic practices of middlemen and traders.) "Quasi-rents" are likely to exist when new fisheries are opened up or new technologies introduced; however, being disequilibrium profits, they are soon eroded by new entrants. Thus, in mature fisheries with well established fishing technologies, the major components of profits are likely to be rents of ability and resource rents. Differences in pure profits between users of the same technology (fishing gear) in the same location (fishing ground) are likely to be due to differences in rents of ability. On the other hand, differences in average pure profits between identical fishing gears operating in different locations are likely to be due to differences in resource rents — assuming no significant differences in prices and sociocultural context between locations.

What gives rise to resource rents? Resource rents, defined as a surplus value over and above the opportunity costs of all factors of production employed in a competitive fishery, arise from ownership of or access to a valuable resource in limited supply. Resource rents are maximized at that level of effort, E_1 (number of fishing trips), at which the marginal cost of effort equals the marginal revenue of effort (Fig. 1). It is in the best interest of the society, or whoever is supposed to be the resource owner, that resource rents be maximized because these rents are the return to the ownership of the resource. In an open-access fishery, however, where "everybody's property is nobody's property," resource rents are nonappropriated income that, as such, attracts new entrants into the fishery until fishing effort expands to E_3 where costs have risen (and revenues declined) so much that all resource rents are competed away (dissipated). Therefore, in an open-access fishery, resource rents can only be a temporary feature found in newly opened fisheries, or where a new resource has been discovered or fish prices have suddenly risen or fishing costs have suddenly dropped. If a certain fishery or segment of a fishery is earning resource rents, it would be necessary to establish whether these are temporary or permanent by examining the trend in these rents over time, the flow of new entrants into the fishery, and recent developments in fish prices, fishing costs, etc. If these rents are shown to persist over time and entry is slow or nonexistent, one must ask what prevents other fishermen from entering the particular fishing ground or acquiring the particular fishing gear and competing these profits away, i.e., what are the barriers to entry? These may range from economic factors, such as high capital requirements and special skills, to sociocultural and institutional constraints, such as caste restrictions, religious prohibitions, and customary property rights, which are discussed in a later section.

Fishermen in an open-access fishery in equilibrium, fully adjusted to changing economic and biological parameters, earn on the average zero resource rents, no more and no less; if they happen to earn any resource rents, more fishermen would enter to compete them away; if they earn negative resource rents, some of them would leave until the remaining fishermen suffer no losses. Persistent positive resource rents imply barriers to entry or immobility in the fishery. Persistent negative resource rents (i.e., earnings below opportunity costs) imply barriers to exit or immobility of the fishery. Such immobility may arise from inability to liquidate fishing assets without undue loss, indebtedness, isolation, inadequate knowledge of alternative opportunities, habit or inertia, caste restrictions, and sociocultural bonds.

Although barriers to entry into a profitable fishery result in relatively high incomes for existing fishermen by allowing them to earn some resource rents and hence incomes above their opportunity costs, open access per se should not be blamed for the widespread poverty among small-scale fishermen. It is rather the chronically low opportunity cost of these fishermen, arising from low educational level and scarcity of alternative employment opportunities, that perpetuates their poverty. Barriers to exit from the fishery and barriers to entry into other occupations might further reduce fishermen's earnings by preventing them from realizing their full opportunity cost. It is important to establish whether fishermen are "poor" because they lack better alternatives outside fishing or because they are unable to take full advantage of existing opportunities. The policy implications would differ accordingly.

Costs and Profitability of Small-Scale Fishing Operations in Sri Lanka

Sunimal Fernando[1]

Various types of fishing craft and gear are used in the Sri Lankan small-scale fishery, which exploits a variety of resource conditions. The persistence of these various fishing technologies is partly the outcome of historical accident and partly the result of economic calculation. Different types of craft and gear are suitable for exploiting specific types of fishery resources. Furthermore, the different technologies used in the small-scale fishery have comparative advantages and disadvantages in respect to their fixed costs, fuel costs, internal and external costs, and labour costs (relative to total costs) and also in respect to the earnings of craft owner and crew member-labourer. The different technologies also display different levels of profitability in small-scale fishing operations.

A clear assessment of costs, earnings, and profitability of different combinations of craft and gear in a comparative framework is required to guide the rational allocation of resources in the small-scale fishery within the parameters of national fisheries-development policy. A study of costs, earnings, and profitability in a comparative framework is required before national decisions can be made as to which technologies are to be provided and which are to be discouraged. Furthermore, to facilitate a rational allocation of different types of boat-gear combinations between different locations, locational variation in mean annual revenue and profitability of each specific technology must be analyzed.

In this paper, the costs and profitabilities of the various types of small-scale fishing operations in Sri Lanka are analyzed. Craft-specific and location-specific income and profitability levels are compared and factors responsible for the variations are identified and explained. In addition, I discuss relative capital and labour intensities of different fishing technologies, the operation of quasi-property rights over fishery resources in specific situations, under- and overexploitation of different fishing grounds, the sensitivity of the cost structure of different types of craft to fuel price increases, the relative inflexibility and immobility of capital in different fishing technologies, the external (foreign exchange) and internal cost components of producing fish using different technologies, and the return to labour in the different types of fishing operations. The levels of profitability of different types of fishing operations are also analyzed and compared using alternative indices of profitability. Finally, interlocational variations in profitability are explained in terms of the prevailing conditions of entry in each location.

All data were collected from primary sources by field researchers of the Marga Institute because secondary data on the cost structure and profitability of different types of fishing operations in Sri Lanka, collected through empirical investigations, were not available. Data analyzed in this paper were collected through the administration of questionnaires in 21 fishing villages (marine, lagoon, and inland) purposefully selected for study. The design of the sample on which the findings of this paper are based is presented in detail elsewhere in this volume (p. 73). The nonavailability of time-series data limits the general validity of the research findings because they are based on cross-sectional data for only 1 year, which could have been an atypical year.

[1] I acknowledge the assistance of Ms Hemamala Munasinghe, Mr Willie Gamage, and Mr K.P.N.S. Karunagoda in the preparation of this research paper. The comments of Mr G.I.O.M. Kurukulasuriya and Dr Theodore Panayotou on a draft of the paper are also gratefully acknowledged.

Analytical Framework

The analysis takes place within the basic theory pertaining to the cost structure of production in a market economy. The basic unit of analysis is the boat-gear combination. Fishing operations are distinguished according to technology or type of fishing boat-gear combination and according to location or fishing ground. Fishing units are grouped in this way because of the apparent "immobility" between boat-gear types and between fishing grounds. For historical as well as economic reasons, fishermen have been locked into particular types of technology and locations of operation from which it is not easy to move even if other types of technology and other locations are found to be more profitable.

Even though the fishery resource is considered to be an open-access resource in a legal sense, its exploitation in Sri Lanka is constrained by the operation of sociological factors. The Sri Lankan coastal fishing communities are "closed localized communities" that do not allow persons from outside the "local community" to have access to the fishing ground that each local community exploits as a group. No outsider is allowed to anchor or beach a fishing craft along the shoreline skirting a coastal fishing village. Labour recruitment for boat crews is also from within the "local community." With such restrictions on entry, economic returns to capital and labour are expected to remain much higher than their respective opportunity costs. In other words, with restrictions on entry, fishermen are expected to earn pure profits or positive resource rents, which are defined as the difference between the total (or gross) revenues from the sale of the catch and the total fishing costs. Costs include both fixed and variable cash costs as well as depreciation of fishing assets and imputed opportunity costs of owned factors of production (own capital, own labour and management, and family labour).

In addition to pure profit, several other indicators of profitability are used, such as net income or total return to own factors of production, net economic profit, and return to individual factors such as capital, labour, and management. Net economic profit is used as an indicator of long-term viability of the operation. The return to capital is compared to the going rate of return on investments of comparable risk and the return to labour and management are compared to their opportunity costs or the going wage rate.

In terms of cost structure, the share of fixed costs in total production costs is used as an indicator of the inflexibility and immobility of the fishing operations, the share of fuel costs as an indicator of the vulnerability of different operations (technologies) to rising fuel prices, and the share of external costs as an indicator of foreign exchange requirements and vulnerability to outside factors.

Fishing Assets and Fixed Costs

The value of capital assets owned by the owner of the craft increases with the degree of motorization and the size of craft (Table 1). The current value of capital assets of the owners of mechanized traditional craft is greater than that of the owners of nonmechanized traditional craft but less than that of owners of modern mechanized craft. However, the value of capital assets of beach seine owners is high in relation to that of even the modern mechanized boat owners, because of the high cost of the long beach seine net and the launching craft used in this type of traditional fishing operation.

Table 2 indicates the degree of inflexibility and immobility of the operations carried out by the different types of fishing craft. It is seen that, with the exception of the beach seine, which has a relatively high proportion of fixed costs, mechanization and modernization tend to

Table 1. Distribution (%) of craft owners in the small-scale fishery by value of fishing capital assets, Sri Lanka, 1980.

		Current value of fishery capital (000 LKR)[a]					
Type of craft	Sample size	Below 2.5	2.5–7.5	7.5–25.0	25.0–50.0	50.0–100.0	Over 100.0
3.5-tonner	130	0	0	11	14	44	31
17.5-footer	60	0	7	20	62	11	0
Traditional craft							
Mechanized	100	0	15	78	7	0	0
Unmechanized	305	18	57	14	11	0	0
Beach seine	100	0	0	4	14	19	63

[a]US$1 = 15.63 rupees (LKR).

Table 2. Fuel costs of various craft and gear combinations in the small-scale fishery, Sri Lanka, 1980.

Craft and gear	Sample size	Total costs (LKR)[a]	Fixed costs LKR	Fixed costs %	Fuel costs LKR	Fuel costs %
3.5-tonner						
With drift nets	84	160922	29448	18	41625	26
With drift nets and longlines	14	213393	33833	16	44708	21
With prawn trawl	32	157507	27520	17	34792	22
17.5-footer						
With drift nets	50	77559	12373	16	22404	29
With drift nets for prawns	10	89051	13370	15	24022	27
Mechanized traditional						
Kattumaran with drift nets	50	68981	5768	8	18679	27
Small *oru* with drift nets	50	58507	6525	11	15506	27
Nonmechanized traditional						
Large sailing *oru* with line gear	20	33710	1780	5	950	3
Small *oru* with drift nets	60	23785	1683	7	880	4
Teppam with drift nets	110	22219	1890	9	826	4
Beach seine (*madel*)	100	229347	29786	13	840	<1
Vallam with drift nets	40	18284	1485	8	813	4
Kattumaran with drift nets	4	23872	2076	9	907	4
Jakotu (fish trap)	20	13817	1200	9	813	6

[a]US$1 = 15.63 rupees (LKR).

increase the degree of inflexibility of operations carried out by fishing craft.

Share of Fuel Costs as an Index of Vulnerability

Fuel as a proportion of total costs (Table 2) can serve as an indicator of the vulnerability of different fishing technologies to rising prices of fossil fuels because fuel intensity varies with the type of technology. With the introduction of mechanization of fishing craft, costs of fossil fuels (i.e., diesel, kerosene, and petrol) became one of the major factors affecting the fishing industry. Although mechanized vessels use fuel for both lighting and powering their engines, nonmechanized traditional craft also use some fuel for lighting lamps during fishing operations at night. This dependency on fossil fuels increased after the oil crisis.

The cost of fuel influences most the functioning of the 3.5-ton (28–32 foot) boat, the 17.5-foot fibreglass boat, and the traditional craft with outboard motor. With the introduction of engines, these vessels are able to go further out to sea in search of more productive fishing grounds and bring back a higher output in a shorter time. The quality and the quantity of the output has no doubt been enhanced as a result of mechanization, but, in a mechanized fishery, each time the price of fuel rises, the cost of production also rises and with it the price of fish.

The average cost of 1 lb (0.45 kg) of fish brought in by a 3.5-tonner was 3.94 LKR (15.63 rupees [LKR] = US$1) and the cost of fuel incurred for this product was 0.91 LKR, or 23% of the average production cost (Table 3). With the retail price of fuel at 20.20 LKR/gallon (5.34 LKR/L) this implies that 4.5 gallons of fuel are needed to produce 100 lb of fish (38 L/100 kg). For the more efficient 3.5-ton boat bringing in a larger production of fish at a lower cost (2.05 LKR/lb), fuel accounts for only 10% of the production cost. Prawns brought in by the 3.5-tonner, however, would cost more, as much as 12.95 LKR/lb, because of the higher cost of labour (crew members' share), which is related to the price obtained for the catch, which is significantly higher for prawn than for fish. The fuel cost would be about the same, resulting in a lower percentage (7%) of fuel cost in the production cost — in the case of more efficient craft, fuel amounts to only 3%. Some fishing vessels are known to use fuel to get to and from the fishing grounds but to use a sail for moving around the fishing grounds. Some mechanized boats are known to use a sail for traveling back from the fishing grounds as well, thus saving further on fuel.

The average 17.5-foot fibreglass boat spends 2.95 LKR/lb of fish caught of which 0.89 LKR, or 31%, goes for fuel compared with only 15% for the more efficient craft of the same type and size. The fuel costs of catching prawns by the same craft, however, would be 2% of the

Table 3. Fuel costs of fish produced by various types of mechanized craft in the small-scale fishery, Sri Lanka, 1980.

Craft and catch	Average boats (LKR/lb)[a] Production	Fuel	Fuel as % of production	Most efficient boats (LKR/lb) Production	Fuel	Fuel as % of production
3.5-tonner						
Fish	3.94	0.91	23	2.05	0.21	10
Prawns	12.95	0.91	7	7.62	0.21	3
17.5-footer						
Fish	2.95	0.89	30	1.38	0.20	14
Prawns	14.68	0.89	6	9.54	0.20	2
Mechanized traditional						
Kattumaran (fish)	3.36	0.98	29	2.47	0.34	14
Oru (fish)	2.76	0.84	30	2.17	0.27	12

[a]US$1 = 15.63 rupees (LKR).

production cost of 9.45 LKR in the case of most efficient craft (Table 3). This great advantage of 17.5-foot fibreglass boats bringing in prawns over bringing in fish, as far as fuel costs are concerned, has been recognized by the fishermen in areas where prawns are available. Thus, increasing numbers of 17.5-foot fibreglass boats exploit the prawn fishery in such areas. Of course, reducing the vulnerability to rising fuel prices is only a means toward maximizing net returns. Other things being equal, fishermen may choose the less fuel-intensive technologies or species, but a higher return may induce them to pursue more fuel-intensive fishing, and here the issue of private versus social costs and benefits arises.

The cost of producing 1 lb of fish in the mechanized traditional outrigger canoe (*oru*) is 2.76 LKR with a fuel cost of 0.84 LKR, or 30% of the total average costs for the average craft and 12% for the more efficient craft. However, the cost of production per pound of fish brought in by the mechanized *kattumaran* (a kind of traditional craft) operated off the northern coast was much higher, 3.36 LKR for the average boat and 2.47 LKR for the most efficient boat, with fuel costs of 0.98 LKR/lb of fish for the average craft and 0.34 LKR/lb for the most efficient craft. This was the highest fuel cost per pound of fish for any type of mechanized craft operating in the inshore waters of Sri Lanka. The reason for this is that *kattumarans* consume more fuel while they bring in relatively smaller quantities of fish than the other types of mechanized traditional craft. Some of these craft have a high fuel consumption because twin engines are used. In the light of the high costs and low catch, it would not be advisable to advocate the expansion of the fleet of mechanized *kattumarans*.

This comparison of the different types of mechanized craft indicates that fuel costs per pound of fish are highest in the mechanized traditional craft, whereas the two types of modern mechanized craft incur roughly the same fuel cost per pound because their respective levels of production vary with their levels of fuel consumption. In the context of the possible further increase in fuel prices, should the government want to discourage the use of fuel-intensive types of fishing craft, the whole program of the mechanization of traditional craft will have to be reviewed. The program of encouraging the use of 17.5-footers with outboard engines would also have to be carefully reconsidered.

External and Internal Costs of Different Technologies

With the expansion of foreign trade, and specialization of labour, the production of goods in most modern economies requires external as well as internal inputs. In Sri Lanka, external inputs are most often machinery, fuel, and equipment, whereas internal inputs would be land, labour, and local raw materials. For fisheries in particular, the necessary external inputs are craft, engines, gear, and fuel, and the internal inputs are labour and, of course, the raw material — the resource itself. Cost of fish production today would, therefore, include two main categories of costs, that is, external costs and internal costs.

The analysis here of internal and external cost contributions to the production cost of fish are based on the cost per pound of fish produced (Table 4). The analysis goes a step further to indicate the differences in these costs in the

Table 4. Average total cost and its distribution between external and internal costs in the small-scale fishery, Sri Lanka, 1980.

Type of craft and catch	Average total cost (LKR/lb)[a]	External cost LKR/lb	External cost %	Internal cost LKR/lb	Internal cost %
	Marine				
3.5-tonner					
Fish	3.94	1.36	35	2.58	65
Prawn	12.95	1.36	11	11.59	89
17.5-footer					
Fish	2.95	0.90	31	2.05	69
Prawn	14.68	0.90	6	13.78	94
Mechanized traditional					
Kattumaran (fish)	3.36	1.20	36	2.16	64
Oru (fish)	2.76	1.07	39	1.69	61
Nonmechanized traditional					
Oru (fish)	2.36	0.08	3	2.28	97
Teppam					
Fish	3.65	0.17	5	3.48	95
Prawn	12.69	0.17	1	12.52	99
Beach seine (fish)	1.47	0.01	1	1.46	99
	Inland				
Oru (fish)	0.91	0.02	2	0.89	98
Teppam (fish)	1.09	0.01	1	1.08	99
Cast net (fish)	1.66	0.02	1	1.64	99
Jakotu (fish trap)					
Fish	4.31	0.57	13	3.74	87
Prawn	9.67	0.58	6	9.09	94
	Lagoon				
Vallam (fish)	1.47	0.01	1	1.46	99

[a]US$1 = 15.63 rupees (LKR).

different types of fisheries (marine, lagoon, and inland).

The average production cost of fish in 3.5-ton boats was 3.94 LKR/lb with 35% of the costs being external and 65% internal. The internal cost is high because of the high labour input needed for this craft — an average of four crew members. The 3.5-tonners engaged in fishing for prawns show a quite high production cost per pound, 12.94 LKR, with external and internal costs of 10 and 90%. This is, as mentioned earlier, due to the increased value of crew members' share in the prawn fishery.

The external and internal costs of producing 1 lb of fish by using 17.5-foot boats was found to be 0.90 and 2.05 LKR, with the percentage of internal costs, mainly labour, being as high as 70%. The 17.5-foot boats engaged in prawn fishing have a still higher percentage of internal costs (83%). This is again because the value of the share that the crew members earn is much higher in boats engaged in prawn capture.

The external and internal cost components of mechanized *kattumarans* that are operated in the north are 36 and 64% of a total average cost of 3.36 LKR/lb. In contrast, the external cost for mechanized *orus* operating in the south is 39% of a total average production cost of 2.76 LKR. It is surprising that there is not a greater difference in the external and internal costs between these two types of mechanized traditional craft because the *kattumarans* sometimes use two outboard motors, thus increasing external costs, and the crew of an *oru* sometimes comprises three members, thus increasing the internal costs, while the *kattumaran* is very often operated by only two crew members.

The other types of nonmechanized traditional craft and gear in the marine fishery have negligible external cost, under 5% of total (Table 4). In some instances, the external cost of producing 1 lb of fish is as low as 0.01 LKR as in the case of the nonmechanized *oru*. Most of these traditional craft are constructed by the fishermen themselves using local raw materials. Whatever external costs they incur are mainly due to occasional use of imported gear. Even in the case of the *jakotu* — an estuarine fish trap constructed by planting poles in the river and weaving bamboo sticks and reeds between them — the external cost component was only 14% for fish and 6% for prawns.

Table 4 shows that the systems with the highest percentage of external costs in the total cost of production are the *jakotu* for inland fish and the 3.5-tonner and mechanized traditional craft for marine fish. The external component of most traditional craft is less than 5% of the total cost compared to 15–39% for mechanized craft.

Gross Revenues and Net Incomes and Profitability

The annual revenue is the monetary value the fisherman derives from his catch, most of which is sold, although a few pounds are kept for his own and his crew members' use. The modern boats have the highest levels of total annual revenue (Table 5) followed by the mechanized traditional craft. The unmechanized traditional craft have, as expected, the lowest annual revenues. Thus, mechanization and modernization of craft have increased the gross revenues per fishing unit. A notable exception to this pattern is the beach seine which, although an unmechanized traditional technology, shows an average total annual revenue of about 345 000 LKR for the centres sampled. As discussed later, the high annual revenue levels (and the implied resource rents) of beach seines are related to the quasi-property rights that the beach seine owners exercise over sections of the sea bordering the shoreline.

Net income is defined as gross revenues minus payments (explicit and implicit) to factors of production purchased or rented by the fishing unit. Thus, net income is the return to own factors of production including family labour. Unlike gross income, which does not make provisions for depreciation, net income is net of depreciation and hence sustainable over the long run. From Table 5, which records the net income of different craft-gear combinations, it is evident that variations in net income follow closely the variations in gross annual revenues: beach seines, 3.5-tonners with nets and longlines, and 3.5-tonners with prawn trawls come at the top of the income scale with nonmechanized traditional craft, other than beach seines, at the bottom.

Table 5 also presents four alternative indices of profitability — net economic profit, pure profit or resource rent, return to capital, and return to management — all of which have been defined as part of the theoretical framework to this study. All types of fishing technology studied were found to have positive net economic profit, an indication of long-term viability.

By deducting the opportunity cost of management from net profit, we obtain a measure of pure profits that may be attributable to monopoly power, superior efficiency, or resource rent. In the case of the fishery, monopoly rents as a

Table 5. Mean annual revenue and profitability per fishing unit of various craft and gear combinations in the small-scale fishery, Sri Lanka, 1980.

Craft and gear	Sample size	Gross annual revenue (LKR)[a]	Net income (LKR)	Net economic profit (LKR)	Pure profit or resource rent (LKR)	Return to capital (%)	Return to management per man-day[b] (LKR)
3.5-tonner							
With drift nets	84	195585	50239	34663	16578	44	101
With drift nets and longlines	14	289581	96302	76188	52774	79	158
With prawn trawl	32	220878	79371	63371	40556	109	364
17.5-footer							
With drift nets	50	113719	44406	36160	18162	85	142
With drift nets for prawns	10	125734	47657	38507	16241	73	151
Mechanized traditional							
Kattumaran with drift nets	50	94351	29339	25430	5794	57	89
Small *oru* with drift nets	50	88862	35337	30355	14882	150	149
Large sailing *oru* with line gear	20	48700	17590	14990	8142	159	75
Small *oru* with drift nets	60	33747	12090	9960	1042	48	50
Beach seine (*madel*)	100	344749	147029	115402	106635	100	607
Teppam with drift nets	110	37643	17490	15424	6684	156	77
Vallam with drift nets	40	29499	12800	11215	4040	122	37
Kattumaran with drift nets	4	45087	22300	21215	12663	223	96
Jakotu (fish traps)	20	30837	13700	17020	5020	385	236

[a]US$1 = 15.63 rupees (LKR).
[b]1 man-day is defined as an 8-hour day.

source of pure profits may be eliminated by the observation of keen competition among fishermen. Although rents of efficiency and premium for risk cannot be so easily eliminated, the pure profits (Table 5) are of such a magnitude that they must include a considerable amount of resource rent. Virtually all craft-gear combinations enjoyed positive pure profits. In what follows, pure profits are treated as synonymous to resource rents.

Resource rents appear to be particularly high for the beach seines (a traditional nonmechanized technology) and for the 3.5-tonners with prawn trawl. The enormous resource rents, 106635 LKR, enjoyed by beach seines are undoubtedly due to the quasi-property rights that beach seine owners exercise. In most parts of the coast, these quasi-property rights have broken down and the large profits once enjoyed by the beach seine owners have been competed away by small *oru, teppam, kattumaran*, and 17.5-foot boat operators who intercept with their small-mesh drift (gill) nets a part of the potential harvest of the beach seines. In three of the centres studied — Nagarkovil, Udappuwa, and Mawella — however, beach seine owners have been able to protect their quasi-property rights from potential competitors with a greater degree of success.

Because the shoreline suitable for beach seine operations is limited — the sea adjoining it must be free of obstacles for beach-seining — those beach seine operators who have acquired rights over such shoreline should be in a position to prevent new beach seine owners from acquiring rights to operate their nets from the same beach thereby reducing the number of "turns" per beach seine per unit of time. They should also be in position to constrain or restrict operators of small craft from intercepting the shoals that would otherwise form the beach seine harvest. In most parts of the coast, the beach seine system of fish production has declined — in 1975, beach seines accounted for as much as 30% of the island's fish production but, by 1978, the figure had declined to 9% (Fernando 1979).

The substantial difference in resource rents between 3.5-tonners using dual technology of drift net combined with longline (53000 LKR) and 3.5-tonners using only drift nets (17000 LKR) is more difficult to explain. If dual technology is so profitable, why do more fishermen not use it? Of course, cost is one consideration because a set of lines costs around 25000 LKR, which is also the approximate cost of drift nets — therefore, dual technology means doubled gear costs. Moreover, there are additional costs associated with the operation of a dual technology. After laying the drift nets within the continental shelf, the boat moves further out to sea and lays its baited longlines beyond the shelf: bait is obtained from the catch of the drift nets during the previous trip. A fishing trip with dual technology takes about 36 hours to complete, much longer than with single gear technologies, because of the time used to move between fishing grounds and to lay and gather two sets of gear. It is also necessary to employ additional labour (and capital) to watch over the one set of gear, to reduce damage from passing ships, while the fishing unit is laying the other gear. Yet these reasons cannot explain why dual technology is practiced mainly at Pitipana (north of Colombo) and at Auruwala (on the southwestern coast) and has not spread to the south where conditions are more suited to the dual technology — the continental shelf is close to shore. More research is needed to identify the constraints to the spread of the, apparently, very profitable dual technology.

Another technology that has not spread as much as one would expect, considering its high profitability, is prawn trawling with a 3.5-tonner. Although prawn trawling yields more than twice as much pure profit as drift netting, many more 3.5-tonners practice drift netting than prawn trawling. Two factors constrain the spread of the prawn trawling technology. For one thing, prawn trawling grounds are few — from Mattakotuwella to Udappuwa, from Talaimannar to Pesalai, from Colombo harbour to Hendala, and from Lewis Place to Negombo and Kochchikade. Therefore, only 3.5-tonners operating in fishing villages within reach of these prawn trawling grounds can even consider entering this high net-income yielding fishery. Moreover, in some areas, such as the Mattakotuwella–Udappuwa stretch, there is severe tension between the prawn trawling fishermen and the 17.5-footer and *teppam* fishermen. The tension frequently erupts with violence both at sea and on the shore. This factor also inhibits a larger number of fishermen from entering this fishery. It is as a result of the operation of such constraints to the entry of larger numbers of fishermen into the 3.5-tonner prawn trawling fishery of the Mattakotuwella–Udappuwa area, that there has been a perpetuation of the high margins of net income, a part of which would otherwise have been competed away through a substantial increase in the number of 3.5-tonners prawn trawling on the same fishing grounds.

One index of profitability in Table 5 is the return to capital. This can be compared to the current rate of return from investments in other activities of comparable risk. Types of fishing activity where the return to capital is equal to or bigger than the return from investments of comparable risk, are considered to be "profitable." It is unfortunate that the percentage return to capital earned in other sectors of the rural economy are not available for comparison. In the absence of comparable data, one way of assessing the profitability of fishery investments by using the index of "return to capital" would be to use the prevailing interest rate (or return on government-guaranteed fixed deposits) adjusted for risk. The prevailing interest rate in 1979 was 18% which, even if doubled to allow for the higher risk of fishing, is still considerably below the rates of returns enjoyed by the small-scale fishery, which ranged between 44% for the 3.5-tonners with drift nets to 385% by *jakotu*. Because of their very small capital investment, unmechanized traditional craft generally have higher rates of return than mechanized traditional or modern craft.

Labour Intensity and the Share System of Labour Remuneration

The share of labour costs in total costs of production is an indicator of the labour intensity of different fishing technologies. Labour intensity decreases with mechanization and modernization and the traditional fishing technologies remain the most highly labour intensive (Table 6).

In the Sri Lankan small-scale fishery, the crew is always paid a share of the value of the catch and not a fixed wage rate. In addition to the share-basis of payment, each crew member receives a few pounds of fish after every fishing trip for home consumption and is also provided with food during the time the boat is out at sea. The value of all these items together comprise his total earnings.

In the case of all types of mechanized craft, half the proceeds of the sale of catch, after deduction of the costs of fuel, bait (if any), and food, is divided equally among the members of the crew and the other half accrues to the owner of the craft and gear. In the case of nonmechanized traditional craft that do drift netting or line fishing, the basis of sharing of proceeds after deducting the costs of bait, food, and fuel for lamps is one-third to the crew and two-thirds to the owner of craft and gear. For the beach seine, half the proceeds after deducting the costs of food and fuel (if used for lighting) go to labour and the other half to the owner or owners (such as in the case of Mawella where each beach seine net is owned jointly by a group of eight shareholders).

The share system of labour remuneration has an important bearing on the amount of risk borne by the two factors of production — capital and labour. Under a fixed wage system,

Table 6. Average earnings of labour employed in various types of craft-gear combinations in the small-scale fishery, Sri Lanka 1980.

Craft and gear	Sample size	Return to labour per man-day[a] (LKR)[b]	Annual earnings of a crewman (LKR)	Labour as % of total cost
3.5-tonner				
With drift nets	84	59	18085	45
With drift nets and longlines	14	49	23414	44
With prawn trawl	32	131	22815	58
17.5-footer				
With drift nets	50	71	17998	46
With drift nets for prawns	10	87	22226	51
Mechanized traditional craft				
Kattumaran with drift nets	50	69	19636	57
Small *oru* with drift nets	50	61	15533	53
Large sailing *oru* with line gear	20	34	6848	81
Small *oru* with drift nets	60	45	9960	75
Teppam with drift nets	110	44	8781	79
Beach seine (*madel*)	100	30	4943	75
Vallam with drift nets	40	24	7175	78
Jakotu (fish traps)	20	154	11100	80

[a]1 man-day is defined as an 8-hour day.
[b]US$1 = 15.63 rupees (LKR).

all risk arising from the vagaries of nature as well as from the fluctuations of the market (as well as benefits arising from windfall harvests) will be borne (or enjoyed) by the owners of fishing capital, while the crew would be assured of a steady income not lower than the opportunity cost of their labour (assuming perfect mobility). Under the sharing system, on the other hand, the crew bears a part of two types of risk, the risk of low catch and the risk of low market price, and also enjoys a part of the benefits arising from windfall profits that could result from unusually large hauls of fish and favourable changes in market conditions. Crew paid on a share basis ought, therefore, to enjoy higher average earnings than crew paid on a fixed wage basis, because the earnings of the former incorporate a premium for risk taking. The earnings of crew members who are remunerated on a share basis would thus be higher than the opportunity cost of their labour (i.e., the wage rate of land-based workers of similar skill) and a comparison of the earnings of fishery crew members with those of land-based workers of similar skill would be unrealistic if no adjustment is made for risk taking.

The sharing system of labour remuneration in the small-scale fishery has yet another implication for income distribution because, if the supply of labour to a particular fishing centre is relatively inelastic or there are barriers to entry (as is the case in Sri Lanka), the crew would also enjoy a part of the resource rents of the fishery. Hence a comparison of the earnings of crew members working on a share-system of labour remuneration on different types of craft and in different locations could be used to identify types of craft and locations that could yield high fishery resource rents, provided of course that the opportunity costs of labour are more or less equal for the different types of craft and locations.

Table 6 also describes the average return to labour per 8-hour man-day for each type of fishing activity as well as for different locations. Return to labour is highest in modern mechanized craft, lower in the mechanized traditional craft, and even lower in the unmechanized traditional craft with the exception of the *jakotu*.

Keeping in mind that these values also incorporate a premium for risk bearing, it would be appropriate to compare these earnings with the income per man-day earned by those in rural land-based occupations. According to the Marga Institute's (1980b) village survey, which was also conducted in 1980, an agricultural labourer at that stage earned 27.50 LKR/man-day whereas a carpenter earned 45.00 LKR. The values for return to labour per man-day in fishing (Table 6) are substantially higher than the agricultural wage rate, a consequence of the sharing system of labour remuneration and the existence of resource rents.

Interlocational Variations and Quasi-Property Rights

Annual revenues and pure profits or resource rents for selected technologies varied among locations (Table 7). Because total revenues and resource rents appear to be correlated and revenues serve also as an indicator of physical resource availability, both in terms of quantity and quality, the following discussion is in terms of total revenues. Differences in annual revenues (or more appropriately resource rents) can be attributed to differences in the conditions of entry into (and exit from) the fishery, that is, the presence or absence of quasi-property rights over the resource.

Mean annual revenue from 3.5-tonners engaged in drift netting — the dominant gear type of the Sri Lankan small-scale fishery — is lower in certain centres than in others (Table 7). For instance, Myliddy (on the northern coast) has a lower annual revenue level in the 3.5-tonner drift net fishery than the other centres studied except Barudelpola: this may reflect a poor fishery resource in the fishing grounds off Myliddy, poor in both quality and quantity. It is observed that a large part of the catch of the 3.5-tonners in Myliddy consisted of varieties of small fish that fetch comparatively low prices and generate low incomes to the craft owners. The other reason for the comparatively low level of average total revenue of 3.5-ton boat owners at Myliddy is that the sea off this centre is relatively calm at all times of the year and smaller types of craft (17.5-foot boats, *kattumarans*, etc.) can also go out to the same fishing grounds as the bigger 3.5-tonners and compete for the same resources, thereby depressing the annual revenue earned by the owners of 3.5-ton boats. Generally, the 17.5-foot fibreglass boat with outboard engine does not go as far out to sea as the 3.5-tonners with inboard engines.

The 17.5-foot craft has considerable interlocational variation in mean annual revenue. Myliddy, Mullativu (on the eastern coast), and Uswetikeiyawa (just north of Colombo) show the highest total annual revenue levels.

The reasons for the relatively higher annual

Table 7. Interlocational variation of revenues and resource rents (LKR)[a] by type of craft in the small-scale fishery, Sri Lanka, 1980.

Location	3.5-tonner		17.5-footer		Marine *oru*		*Kattumaran*		*Teppam*		Beach seine		Lagoon *vallam*	
	Revenue	Resource rent	Revenue	Resource rent	Revenue	Resource rent	Revenue	Resource rent	Revenue	Resource rent	Revenue	Resource rent	Revenue	Resource rent
Coastal														
Myliddy	165550	22549	112892	21003	–	–	95210	13129	–	–	–	–	–	–
Mirissa	198934	37693	–	–	–	–	–	–	–	–	–	–	–	–
Kudawella	189584	41539	85668	20020	40060	2936	–	–	–	–	–	–	–	–
Mullativu	–	–	111505	4336	–	–	45087	7307	–	–	–	–	45087	22300
Thoduwawa	–	–	94280	19062	–	–	–	–	37674	7879	–	–	–	–
Chilaw (small fish)	–	–	90570	15451	–	–	–	–	–	–	–	–	–	–
Chilaw (prawns)	–	–	125734	16241	–	–	–	–	–	–	–	–	–	–
Nagarkovil	–	–	–	–	–	–	–	–	–	–	382350	126770	–	–
Udappuwa	–	–	–	–	–	–	–	–	41355	8988	398500	172642	–	–
Mawella	–	–	–	–	–	–	–	–	–	–	204300	52918	–	–
Mattakotuwella	185029	25637	92092	9760	–	–	–	–	36522	6898	–	–	–	–
Barudelpola	157062	15833	–	–	–	–	–	–	–	–	–	–	–	–
Uswetikeiyawa	–	–	126153	34726	–	–	–	–	42487	11515	–	–	–	–
Inland														
Huruluwewa	–	–	–	–	24133	1975	–	–	–	–	–	–	–	–
Ridiyagama Wewa	–	–	–	–	20644	2295	–	–	20716	1055	–	–	–	–
Yodakandiya Wewa	–	–	–	–	20650	962	–	–	–	–	–	–	–	–
Lagoon														
Puttalam	–	–	–	–	–	–	–	–	–	–	–	–	29499	12960

[a]US$1 = 15.63 rupees (LKR).

revenue at Myliddy have already been given. At Mullativu, a fishing village in the eastern province, the comparatively high revenue level reflects the existence of relatively underutilized fishery resources off the east coast resulting from the manner in which subsidies and credit facilities have been allocated to different parts of the island for modernizing and mechanizing the fishing fleet. Allocation of government assistance for fleet modernization has always been guided by political factors: if a certain part of the coastal belt has a spokesperson who has political influence with a governing political party, the interests of the fishermen in that area will be looked after. The western, southern, and northern coastal zones have at various times had powerful representatives in different governments, but the eastern coastal zone has not had a sufficiently powerful political leader through whom they could lobby their interests. Coastal fishery resources off the east coast remain relatively underutilized and revenue at Mullativu reflects this.

The relatively high annual revenue level at Uswetikeiyawa is explained by the composition of the catch, which consists partly of prawns that fetch high prices because of the export market. The 17.5-foot boats in Chilaw concentrating on the prawn fishery register about the same annual revenue as at Uswetikeiyawa.

Among the lowest annual revenues of 17.5-foot boats were those at Thoduwawa, Mattakotuwella, and Chilaw, three centres within close proximity of each other on the northwestern coast. The fishing grounds of these centres that provide the harvest of small, surface-moving fish for the 17.5-foot drift netters, also have mud bottoms with extensive prawn resources, providing rich trawling grounds for the 3.5-tonners of Chilaw, which use a trawl net to catch prawns in these same waters. It is suggested that resource depletion of species of small fish in these fishing grounds is an outcome of the activity of the 3.5-tonner prawn trawlers of Chilaw. Trawling disturbs the sea to the extent that surface-feeding shoals of small fish tend to migrate away from these grounds into the deeper waters. During the past few years, violence has erupted on several occasions between fishermen operating these two different technologies in the same fishing grounds. Because this problem will be a recurring one, and because the prawn resources are more valuable than the resources of surface-feeding species of small fish, and because the one fishery affects the other adversely, the policy of allocating 17.5-foot drift netters to fishing villages between Mattakotuwella and Udappuwa, the two extremes of the prawn trawling grounds, should be carefully reassessed.

The lowest annual revenue level among 17.5-foot boats was recorded at Kudawella on the southern coast (Table 7). This may reflect the unsuitability of this type of craft for the southern and southwestern coasts, which bear the brunt of heavy seas during the southwest monsoon period, making a light boat such as the fibreglass 17.5-footer difficult to manage.

For the traditional craft, annual revenues of small *oru* do not seem to vary significantly in the marine centres studied (Table 7), whereas the annual revenue level of the *teppam* is comparatively low at Mattakotuwella for the same reasons as the low revenue levels of 17.5-foot mechanized boats at this centre. The annual revenue levels of small *oru* and *teppam* operating in inland reservoirs are about half those of the same types of craft operating in marine waters. One reason for this is that the commercial value of *Tilapia mossambica*, which accounts for over 90% of the catch of inland fish, is relatively lower than that of marine fish in general; for another, the values reflect the fact that, at present, fishery resource availability in inland waters is low.

The mean annual revenue of the *vallam* (29 500 LKR) operated in the Puttalam lagoon is higher than the corresponding figures for *oru* and *teppam* operated in inland waters but lower than the corresponding figure for any of the craft operated from the coastal fishing centres. When it is realized that the low revenue of *vallam* operations occurs despite the fact that a part of the resource base of the Puttalam lagoon consists of the high-priced prawns, the situation suggests a low return per unit of fishing effort that, in turn, could be associated with a problem of biological overfishing in brackish-water situations. In contrast, the *jakotu* has a capital value of about a third that of a *vallam* with gear and uses about one-quarter the labour of a *vallam* (72 vs 300 man-days/year) but has a mean annual revenue of 30 837 LKR. Here again, a substantial part of the catch consists of prawns.

A critical variable that accounts for the difference in revenue levels per unit of capital invested is the existence of quasi-property rights in the Puttalam lagoon. In the Moratuwa area (just south of Colombo), river-bound villages along the estuary impose sanctions against outsiders erecting *jakotu* on that part of the river adjoining the village. Entry into the estuarine *jakotu* fishery is thereby constrained, and tendencies toward overfishing can be controlled. In contrast, the local communities living along the Puttalam lagoon are not sufficiently organized to prevent outsiders coming in to exploit the fishery resources of the lagoon. Migrant fishermen from the west coast around Negombo and Chilaw exploit these resources together with the Muslim and Sinhalese fishermen of the villages along the lagoon.

The Muslim fishermen of Karayar Veediya in the town of Puttalam have imposed quasi-property rights over a small part of the lagoon bordering their settlement, but their effect on overall resource management within the lagoon system is minimal because access to most of this large lagoon is open to anyone who may care to come and exploit its resources. In sharp contrast to the brackish- and inland-water situations where returns per unit of effort are low due to resource overexploitation, the operation of the traditional *kattumaran* at Mullativu on the east coast records the second highest annual average revenue (45 087 LKR) for any type of traditional nonmechanized craft. This figure once again reflects the underexploited nature of the east-coast fishery resources due to factors that have already been discussed.

Of the three beach seine centres studied, Nagarkovil and Udappuwa are characteristic of fishing centres where the beach seine system still dominates — however, the processes that brought about the decline of the beach seine elsewhere have shown signs of gathering momentum since this study was completed in 1980. Mawella, by contrast, is a case of a beach seine system that is on the decline.

In general, craft operated from Mullativu on the east coast earned high net incomes (Table 7) for reasons that have been given already. However, it can be asked why craft owners earning relatively lower net incomes in one centre do not move to Mullativu or, for that matter, to other east-coast fishing centres to exploit the east-coast fishing grounds, which are relatively underutilized. Before the development of a fishery industry on the east coast during the last 75 years, the people living along this coast were engaged in agriculture. Fishermen from the southern, western, and northern provinces were known to migrate to the east coast during the off season in their "home" areas. In the course of the years, some seasonal migrants settled and formed new fishing settlements on the east coast. At the same time, some of the Tamils and Muslims of the original communities on the east coast also became familiar with marine fishing techniques and began to take up fishing as an occupation. For instance, the early settlers of Mullativu were engaged in agriculture, but when migrant fishermen from areas like Myliddy in the north, Negombo on the west, and Gandara in the south came and settled there, the agricultural economy gradually shifted to a fishing economy.

As permanently settled fishing communities developed in individual centres along the east coast, they imposed communal quasi-property rights over their fishing grounds by not allowing outsiders to carry out fishing operations off their villages. Seasonal migrants as well as permanent migrants are permitted to operate off host fishing villages only when the local fishing communities are weakly organized. Once the local fishing community is organizationally able to do so, it imposes communal property rights over the fishing grounds. These rights then serve as barriers to entry for seasonal, as well as permanent, migrant fishermen from other centres. The communal property rights over fishing grounds are imposed by preventing outsiders beaching their craft on the beach or anchoring their boats offshore, thereby effectively cutting off access to the fishing grounds. This practice is common to all coastal villages in Sri Lanka. Thus fishing craft from relatively overexploited centres cannot have ready access to the fishing grounds of relatively underexploited, high income-generating fishing centres.

The analysis of average net income levels also shows that the lowest average net incomes for craft owners and crew members are recorded in the inland fisheries of the artificial irrigation tanks of the dry zone of the island. When the net income levels of these fishermen are compared with those of cultivators living in a tank village, it is clear why there is no marked mobility of agricultural labour to the inland fishery. The net incomes of fishing craft owners operating in Huruluwewa, Ridiyagame, and Mahakandarawa tanks were between 8000 and 9300 LKR, whereas those of cultivators and sharecroppers of Udeyagiri tank settlement were around 8700 LKR.

The relatively low net-income levels of inland tank fishermen reflect two factors operating in the inland fishery sector: the relatively low commercial value of inland fish such as *Tilapia mossambica*, because of the preference of Sri Lankans for marine fish, and the low biological productivity of the irrigation reservoirs. These reservoirs are artificial ecological systems in a country that has no natural lakes and therefore no typical lake fauna that could populate the artificial irrigation tanks through the rivers. Biological productivity under these circumstances will remain low until the many ecological niches in the irrigation tank systems are identified through research and exotic species of fish are introduced to occupy the empty ecological niches — this has been done, in part, with *Tilapia mossambica*, which was introduced into the inland water bodies in 1952. (For more details on this experience and other possibilities, see Senanayake and Fernando, this volume, p. 269).

Finally, although substantial variations in revenues and profits were observed for the same craft-gear combination operating in different locations, there was considerable uniformity in revenues and profits among craft of the same gear type operating in the same location. This finding supports the hypothesis that differences in profitability among locations are due to differences in resource availability arising from community property rights over the resource.

Policy Implications

One finding of this study is that the more mechanized and modernized the craft or gear, the higher are the net incomes of craft owner and crew members, the level of dependence on external inputs, which require foreign exchange, and the amount of fossil fuels required per pound of fish produced. It is, therefore, clear that there cannot be a strategy of fleet enhancement that both increases net incomes of fishermen and reduces dependency on external inputs (including fossil fuels) at the same time. Any fleet-development plan will necessarily involve policy decisions regarding trade-offs between employment-generation, fishermen's incomes, conservation of foreign exchange, and dependency on fossil fuels. The trade-offs will have to be decided on the basis of broader national policy objectives.

To overcome the factors that constrain fishermen from adopting a dual technology (drift nets and longlines), and thereby earning higher incomes and profits, facilities should be provided for the exchange of signals between fishing boats and large ocean-going vessels. Radio communication facilities should be provided so that fishermen who remain out for long hours could communicate with their homes.

As a step toward raising the income levels of inland fishermen, policy should be directed at developing a marketing and product-development strategy for inland fish varieties; a research program that tries to introduce more exotic varieties as well as acclimatized marine fish species to fill the empty niches in the artificial ecosystems of the inland tanks; and the formulation of realistic fishery resource-management regulations for the inland fishery.

To control resource overexploitation in the lagoon fishery, resource-management regulations, restrictions on entry, monitoring of stocks to check any tendency toward resource depletion, and research directed at enhancing the productivity levels of the brackish waters are matters that should concern policymakers.

A policy decision needs to be taken at some stage as to whether private quasi-property rights over beach seine fishing grounds should continue to receive official government sanction or whether, instead, a system should be introduced whereby the resource rents earned from the beach seine fishery are passed on in greater measure to the beach seine workers and, perhaps, to the society at large through the restructuring of beach seine operations and widening the base of beach seine ownership.

The average income of an agricultural peasant living in an irrigated colonization area is the same as that of an inland fisherman operating in the irrigation reservoir belonging to that area. Hence, in such areas, there is at present no significant movement of labour or capital from the agricultural to the fishery sector. However, if as a result of measures that have been recommended, the income and profitability levels of inland fishermen were to rise, conflict is likely to arise between settled agricultural communities and migrant inland fishermen over questions concerning quasi-property rights over the bodies of irrigation water. Furthermore, much larger numbers of the agricultural peasants themselves will want to have access to the fishery resources. This, in turn, could lead to tension, as well as to overfishing and resource mismanagement. Therefore, although policy is directed toward increasing the income and profitability levels of inland fishermen, it should at the same time include appropriate and realistic regulations for inland fishery-resource management.

It would also be rational to develop a program to encourage migration of fishing craft operating in locations with relatively lower resource rents to locations in the eastern province with higher resource rents because of the underexploitation of the east-coast fishery resources. However, because local communities in the eastern province fishing centres will not allow migrants to settle in their villages, the government could start a system of establishing fishery settlement schemes in those parts of the eastern province where permanent fishing communities have not yet been established. Fishermen could be selected from areas of low resource availability and brought to such fishery settlements after essential infrastructural facilities such as roads, houses, drinking water, better transport services, repair facilities, commercial services, harbours, and anchorages have been developed. Such fishery settlement schemes could be organized on parallel lines to the agricultural settlement schemes of the dry zone.

Last, but certainly not least, the findings presented here suggest that the government policy of granting generous subsidies for the purchase of new fishing craft and gear should be reviewed. Fishermen are already earning incomes substantially above their opportunity costs, even after imputing the unsubsidized market value of the craft and gear in their costs. The high incomes of mechanized modern craft (3.5-tonners and 17.5-footers), in particular, are seen to trigger the breakdown in traditional communal sanctions restricting entry into the small-scale fishery. If left unchecked, this process would lead to dissipation of rents and overexploitation of fishery resources. Thus, modernization subsidies have both distributional and efficiency consequences: they are unfair in the light of our finding that fishermen earn incomes considerably higher than other socioeconomic groups and they may also result in inefficiency if they trigger the breakdown of the communal property rights and result in a cutthroat competition over the most productive fishing grounds. It is possible to strengthen the weakened communal sanctions on entry by phasing out subsidies and "taxing away" some of the resource rents for the use of the society at large. However, if moving from a situation of generous subsidies into one of taxation is not politically feasible, other, more palatable, policy alternatives for accomplishing the same objectives must be investigated.

Mechanization: Its Impact on Productivity, Cost Structure, and Profitability of the Philippine Municipal Fishery

Aida R. Librero, Diego Ramos, and Lustina Lapie[1]

The fishing industry plays an important role in the social and economic life of the Filipinos. Of particular significance is the role of the industry as a source of employment and income and as the major provider of protein to the Philippine's rapidly increasing population.

A number of strategies have been adopted by the fishing industry to cope with the expanding demand for fish and fishery products. These include the use of larger vessels and the shift from traditional to modern and technically more efficient fishing methods.

The development of the fishing technology in the Philippines has been dualistic. Commercial fishing technology has advanced to the use of sophisticated detecting, catching, and processing devices but artisanal or municipal fishing has lagged behind. Small-scale fisheries are known as "municipal fisheries" in the Philippines and include fishermen without boats or with boats not exceeding 3 gross tons — in this study, the terms artisanal, municipal, and small-scale fisheries are used interchangeably. Small-scale fishing employs, with minimal improvement, the traditional techniques of fishing that, coupled with biological constraints related to the open access of fishery resources, have provided little more than subsistence income to municipal fishermen. Ironically, the municipal fisheries is the largest fisheries sector in the country, providing 55% of total fish production.

This study attempts to investigate the economics of small-scale fisheries, particularly the volume of catch, costs and returns, income, and employment aspects as they relate to fishing technology in the Philippines.

Conceptual Framework and Field Survey

It is conventional wisdom that adoption of new technology would improve the income and welfare of small-scale fishermen. However, new technology is successful only if it lowers production costs or raises productivity without depressing product prices. This paper attempts to examine these issues. Productivity, costs, and returns of fishing operations are analyzed for different types of boat, degrees of mechanization, and types of gear. Regional analysis is done to compare the three major island groups of the Philippines — Luzon, Visayas, and Mindanao — and, to a lesser extent, the regions within these island groups.

Production is measured in terms of total volume of catch per year. Costs are differentiated into fixed and variable costs and cash and noncash. Fixed costs constitute those items that, in the short run, cannot be varied by the fishermen — they include such items as depreciation, interest on borrowed capital, and opportunity cost of own capital. Variable costs include day-to-day expenditures on fishing inputs such as fuel, labour, food, etc.

Annual catch is valued in terms of fish prices prevailing at the time of sale to provide an estimate of the total revenue and gross income from fishing. Gross income is distinguished from net income, which is, in turn, measured in different ways to indicate profitability indices

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and returns to investment. Gross income consists of total revenues less cash costs and represents an income that can be utilized by the fishermen without making allowance for replacement of boat and gear. Subtracting depreciation from gross income gives net income, thus providing for purchase of fixed assets in the future. Net income represents return to own capital and family labour. This is differentiated from operating profit or gross economic profit, which is measured by subtracting total variable costs from total revenue. In the short run, a firm (in this case, a fishing unit) will continue its operations as long as variable costs are recovered, that is, gross economic profit is positive. In the long run, however, the firm must recover both fixed and variable costs. Total revenue minus total costs, therefore, must at least be equal to zero. This measure is termed net economic profit. Alternatively, it can be computed by subtracting fixed costs from gross economic profit. A positive net economic profit reflects long-term viability of the fishing unit.

Another concept of profit is pure profit — the net economic profit minus opportunity cost of management, the latter being the income the boat owner could have had from alternative employment. Under perfect competition and long-run equilibrium, pure profit is equal to zero. However, resource sectors like the fishery are capable of generating resource rents or pure profit, if properly managed, but in open-access resource sectors, resource rent dissipates. A negative resource rent means that fishermen's incomes are below their opportunity costs.

Other indices of profitability are:

- Return to capital, which is computed by dividing the sum of pure profit, opportunity cost of own capital, and interest on borrowed capital by the current value of assets;
- Return to management, which is calculated by dividing net profit by the number of man-day equivalents worked by the boat owner; and
- Return to labour, which is the labour cost divided by the total number of hired man-days.

A survey of 506 municipal fishermen was conducted from April to June 1979 in eight regions of the Philippines (for provincial distribution, see fig. 1 in Librero et al., this volume, p. 37) and the data used for this paper were the same as those collected for *The impact of credit on small-scale fisheries in the Philippines* (this volume, p. 223). A multistage sampling technique was used in selecting sample respondents so that the regions and provinces with the larger numbers of fishermen borrowers were selected for the study.

Fishing Technology and Fishing Grounds

The spectrum of fishing technology available to municipal fishermen is very limited due to limitations set by the small boats used and the correspondingly limited area of operation and exploitation. Even where improved technology could be used, the rate of adoption by fishermen is slowed by their inability to provide the needed capital. As a prelude to the economic analysis, we first consider the practices commonly employed by the fishermen, their distribution, and the extent of their adoption.

The most widely used craft is the wooden dugout type of boat (locally called *banca*). For small boats, the dugout constitutes the whole boats, but for bigger boats, the dugout serves as the basic hull with additional boards or plywood used for the sidings.

Not all municipal fishermen used boats for fishing — some used bamboo rafts, reported by 27% of the respondent fishermen in Ilocos region. Although this type of fishing enterprise demands the least capital, fishing is limited to rivers and along estuaries and the shoreline.

For the whole country, the majority of the boats (75%) were motorized (Table 1). Visayas had the highest proportion of fishermen using motorized boats (88%) followed by those in Luzon in general (72%) but within this island group, the region of Central Luzon had practically all fishermen using motorized boats (97%) whereas Ilocos had only 27% with motorized boats.

Among the motorized boats, 48% were powered by engines of at least 15 horsepower (HP) probably because most of the engines that could be purchased under the loan program of the Development Bank of the Philippines (DBP) were of the 16-HP type. By region, the proportion of boats with engines of this horsepower ranged from 6% in Northern Mindanao to 87% in Central Luzon.

Boat size is usually measured by gross tonnage (GT), which is a measure of the hull's water displacement and carrying capacity (net tonnage) where net tonnage equals 0.68 times gross tonnage. Among the fishermen surveyed, boats ranged from 0.12 to 3.00 GT, with an average of 0.78 GT but most of the sample fishermen used boats of less than 1.00 GT (Table 1). Only about

Table 1. Frequency distribution (%) of fishing boats by tonnage, Philippines, 1978-79.

Region	Sample (number)	Motorized	Non-motorized	Tonnage[a] 0.50	0.50-0.75	0.76-1.00	1.01-3.00
Luzon	**255**	**72**	**28**	**27**	**26**	**23**	**24**
Ilocos	64	27	73	55	20	18	7
Central Luzon	64	97	3	2	19	27	52
Southern Tagalog	64	92	8	30	42	20	8
Bicol	63	75	25	30	22	24	24
Visayas	**128**	**88**	**12**	**14**	**35**	**37**	**14**
Western	64	94	6	6	29	49	16
Central	64	83	17	22	41	24	13
Mindanao	**123**	**70**	**30**	**30**	**24**	**30**	**16**
Northern	61	82	18	17	38	35	10
Southern	62	58	42	43	11	25	21
Philippines	**506**	**76**	**24**	**24**	**28**	**28**	**20**

[a]Based on a somewhat smaller total sample of 475 fishing units.

Table 2. Distribution (%) of types of fishing gear by region, Philippines, 1978-79.

Region	Sample size	Gill net	Baby trawl	Lift net	Beach seine	Net and lines	Long-line	Hand-line	Other[a]
Luzon	**254**	**35**	**14**	**10**	**0**	**4**	**22**	**5**	**10**
Ilocos	64	28	6	39	0	0	27	0	0
Central Luzon	63	49	49	2	0	0	0	0	0
Southern Tagalog	64	41	0	0	0	5	44	9	2
Bicol	63	21	0	0	0	13	17	11	37
Visayas	**128**	**63**	**18**	**0**	**0**	**2**	**8**	**2**	**7**
Western	64	70	28	0	0	0	0	0	2
Central	64	56	8	0	0	3	17	3	13
Mindanao	**123**	**20**	**2**	**0**	**20**	**22**	**5**	**11**	**20**
Northern	61	16	3	0	38	18	3	11	10
Southern	62	23	0	0	3	26	6	11	31
Philippines	**505**	**38**	**12**	**5**	**5**	**8**	**14**	**6**	**12**

[a]Includes combined handlines and longlines, lift nets and other types of nets, hand instruments, and barriers and traps.

19% were operating boats of more than 1.00 GT of which 36% were from Central Luzon where more than 50% of the boats were above this size.

Several types of catching gear are used in the Philippines. They include longlines, and handlines, gill nets, lift nets, seines, fish corrals, bag nets, fish shelters, and spears. (A brief description of these types of gear is given in the appendix.)

Various types of catching gear are being used in the different regions of the country (Table 2), but nets were the most common, reported by 60% of the respondents. The next most common was lines (20%) although 8% used a combination of both lines and nets in their operation. The remaining 12% used a variety of methods, including hand instruments (mostly spear gun), and barriers and traps, which include fish corrals and other fish traps, used by 4% of respondents.

The gill net is the single type of gear most widely adopted in all the regions of the country (38%) mainly because it is relatively low priced and versatile — it can catch almost any kind of fish that is present depending on mesh size.

Longline is another type of gear being used widely (14%) except in Central Luzon and Western Visayas where it is not used. By contrast, it is the most common gear in Southern Tagalog (44%).

Although not reported in at least three regions, baby trawl was employed by 12% of the total sample, mostly in Central Luzon and Western Visayas. Hand instruments, mostly spear guns, were reported only by 3% of the sample fishermen. The least common types of gear were barriers and traps.

By relating the type of gear to the type of boat used, it was observed that more fishermen preferred to use gill nets than any other specific type of gear. Nonmotorized boat users in a lesser degree also preferred to use gill nets in addition to longline and lift nets.

Because the respondents were geographically distributed, the average distance traveled from their home offshore was used as an indicator of the fishing ground being exploited. Fishermen from Central Luzon traveled the longest distance per fishing trip (67 km). This was made possible by their relatively larger boats and more powerful engines (Table 1). In contrast, fishermen from Ilocos with smaller boats, many of which were nonmotorized, traveled, on the average, only 3 km.

Average Productivity of Boat and Gear

Motorized boats had, on the average, larger output than nonmotorized boats (2560 vs 1118 kg/year, Table 3). Among the motorized boats, the catch was highest in Central Luzon (4128 kg/year) and lowest in Ilocos (955 kg/year). Among nonmotorized boats, catch was highest in Bicol (3216 kg/year) and lowest in Western Visayas (239 kg/year). The very low production of nonmotorized boats in Western Visayas could be attributed to the small size of their boats (all less than 0.50 GT),which was a severe constraint on their operations.

Among motorized boat users, production varied according to the power of engine used (Table 3): production increased with increasing horsepower. Catches ranged from 1472 kg/year for 3–8 HP category, up to 3288 kg for the highest HP category. The positive association between catch and motor power may be explained by the ability of fishermen with more powerful engines (and larger boats) to exploit

Table 3. Annual production (kg) per vessel classified by horsepower of motor and by region, Philippines, 1978–79.

	Motorized (horsepower)					
Region	3–8	9–14	Over 14	Total	Non-motorized	Total
Luzon	**2068**	**2375**	**3546**	**3181**	**1378**	**2686**
Ilocos	–	1055	842	955	785	830
Central Luzon	1153	3195	4380	4128	440	4013
Southern Tagalog	1655	1820	2363	2275	1445	2210
Bicol	2959	2890	5718	3875	3216	3708
Visayas	**930**	**2058**	**2415**	**2039**	**588**	**1868**
Western	260	2417	3410	2770	239	2620
Central	982	1359	1164	1186	714	1103
Mindanao	**1505**	**1937**	**4458**	**1893**	**823**	**1569**
Northern	1269	1200	5244	1495	705	1352
Southern	2039	2575	3869	2462	873	1785
Philippines	**1472**	**2144**	**3288**	**2560**	**1118**	**2213**

Table 4. Annual production by type of catching gear and boat types, Philippines, 1978-79.

	Motorized		Nonmotorized		Total	
Type of gear	Number	Production (kg/yr)	Number	Production (kg/yr)	Number	Production (kg/yr)
Lines	**81**	**1782**	**42**	**955**	**123**	**1499**
Longline	45	1493	28	992	73	1301
Handline	22	2148	7	911	29	1825
Handline and longline	14	2136	7	950	21	1741
Nets	**259**	**2783**	**64**	**1293**	**323**	**2489**
Gill net	161	2694	30	945	191	2433
Baby trawl	60	3328	0	–	60	3328
Beach seine	21	958	5	1566	26	1075
Lift net	2	1102	24	735	26	763
Other nets[a]	15	4162	5	5786	20	4568
Combined nets and lines	**36**	**3928**	**4**	**685**	**40**	**2704**
Other gear	**6**	**1200**	**11**	**882**	**17**	**994**
Hand instrument	4	932	9	750	13	806
Barriers and traps	2	1738	2	1474	4	1606
All types	**382**	**2560**	**121**	**1118**	**503**	**2213**

[a]Includes bag net, seine net, purse seine, scissors net, and others.

farther and more productive, or less exploited, fishing grounds.

Gross tonnage of boat and rate of production also appeared to be positively related. The highest production was obtained on the largest boats (4095 kg/year) and the lowest by the smallest boats (1230 kg/year). This positive association between catch and tonnage was expected because of the positive association between tonnage and horsepower whose combined effect is to increase ability to fish more abundant grounds than those in inshore waters fished by smaller boats.

For both motorized and nonmotorized boats, textile-based types of gear performed better than nontextile types (Table 4). Nets produced better than lines (2489 vs 1499 kg/year).

Most types of gear were more productive when used in motorized than in nonmotorized boats except for beach seine and "other nets" where motorization was not an apparent advantage. Yet among motorized boats, "other nets" (including bag net, seine net, purse seine, and scissors net) obtained the largest catch (4162 kg/year) followed by baby trawl (3328 kg/year). The least efficient gears were hand instruments.

It may come as a surprise that "other nets" operated by nonmotorized boats were by far the most productive but this result should be regarded with some caution because of the small sample size.

Cost Structure

The fishermen were classified according to status of boat ownership. Of the 506 fishermen interviewed, 80% were boat owners. Nonboat owners were further classified into boat renters (6%) and shareworkers or fishermen labourers (14%). A boat owner is a fisherman who owns a boat, whether motorized or not. A boat renter is one who pays a certain amount, either a fixed rate or a percentage of the fishing income, to a boat owner for the use of his boat. A shareworker is a fisherman who works with either a boat owner or a boat renter and is paid a percentage of the proceeds from fishing.

Fishermen's fishing assets consisted of items such as boat, motor or engine, fishing gear, lighting system, containers, ice boxes, etc. The average capital investment on these items by all fishermen (Table 5) amounted to 1871 PHP (in 1979, 7.38 pesos [PHP] = US$1). Investment of motorized boat owners amounted to 2924 PHP or about six times more than that of nonmotorized boat owners. The engines of motorized boats alone accounted for 47% and the hull for 25% of capital investment. For owners of nonmotorized boats, the fishing gear, not the boat, accounted for the bulk (54%) of their capital outlay. Boat renters and shareworkers who did not own a boat and engine had only 95 and 110 PHP in capital, respectively, mainly in fishing gear and a lighting system.

In the cost structure analysis for fishing units, only boat owners were considered, because boat renters and shareworkers did not invest in the operation and often did not know exactly the expenses incurred in the operation. Fishermen were grouped according to geographic location — Luzon, Visayas, and Mindanao. In each geographic group, fishermen were further classified according to the type of fishing gear used — gill net, baby trawl, and other nets (bag net, seine net, beach seine, scoop net, and others); handline and longline; and other gear (spear, fish corral, and fish traps, which were usually of the textile type). Further, they were classified according to whether boats were motorized or not.

Variable costs include cash costs, such as labour, fuel, and other expenses (food, mainte-

Table 5. Current value of capital investment (PHP/fishing unit) of sample fishermen by status, Philippines 1978-79.

Item	Boat owners: Motorized (295)[a]	Boat owners: Non-motorized (97)	Boat owners: Total (392)	Boat renters (30)	Share-workers (65)	Total (487)
Boat	734	185	598	0	0	481
Engine	1387	0	1044	0	0	840
Fishing gear	676	262	574	50	101	478
Lighting system	103	33	86	37	7	72
Other[a]	24	6	19	8	2	17
Total	2924	486	2321	95	110	1888

[a]Values in parentheses are numbers reporting.
[b]Includes containers, painting equipment, and construction and repair materials.

nance costs, marketing costs, and the like), and opportunity cost of family labour. The cost of labour was usually the share of other fishermen in the unit, which often was a percentage of the proceeds from fishing operations. The labour costs of hired fishermen (or shareworkers) of motorized boats were about 3.5 times higher than the labour costs of nonmotorized boats (Table 6) but, as a percentage of the total costs, labour costs of nonmotorized boats were higher because of their higher labour intensity (24 vs 17%).

Fuel was the major single item of expenditure for motorized boats. It constituted 39% of total costs. Other expenses included:

- Other running expenses, ice for fish handling, kerosene or battery for lighting system, food for fishermen, rent on equipment, etc.;
- Maintenance costs, repair of boat and gear, repainting of boat, and purchase of nondurable equipment; and
- Marketing costs, port and market fees, ice, transportation costs, and brokers' fee.

In general, expenses on these items were also larger for motorized than for nonmotorized boats in absolute terms but were a smaller percentage of total costs (22 vs 49%).

Another item included under variable costs is the opportunity cost of family labour. This cost

Table 6. Variable, fixed, and total costs (PHP)[a] per fishing unit by gear type and location, Philippines, 1978-79.

Region	Sample size	Variable: Cash: Labour	Variable: Cash: Fuel	Variable: Cash: Others	Variable: Opportunity of family labour	Fixed: Cash: Interest on borrowed capital	Fixed: Depreciation	Fixed: Opportunity of own capital	Total cash	Total variable	Total costs
Luzon											
Gill net											
Motorized	52	1952	5053	2689	437	190	1138	285	9884	10131	11744
Nonmotorized	15	1132	0	1114	0	52	283	71	2298	2246	2652
Baby trawl											
Motorized	19	2066	5035	2952	313	178	731	183	10231	10366	11458
Other nets											
Motorized	12	2545	3587	3682	782	257	1398	350	10071	10596	12601
Nonmotorized	21	918	0	952	861	68	88	22	1938	2731	2909
Handline											
Motorized	8	1114	4524	2221	0	326	870	217	8185	7859	9272
Nonmotorized	3	0	0	695	0	0	47	12	695	695	754
Longline											
Motorized	36	82	3188	2308	229	206	744	181	5784	5807	6938
Nonmotorized	18	0	0	1731	221	78	56	14	1809	1952	2100
Nets and lines											
Motorized	10	2013	3426	2686	720	429	1157	288	8554	8845	10719
Total sample[b]											
Motorized	144	1449	4251	2682	398	238	967	242	8620	8780	10227
Nonmotorized	59	614	0	1193	374	61	125	31	1868	2181	2398
Visayas											
Gill net											
Motorized	57	882	2450	1062	815	189	816	204	4583	5209	6418
Nonmotorized	4	20	0	363	2225	0	87	9	383	2608	2704
Baby trawl											
Motorized	19	693	2700	809	474	251	747	187	4453	4676	5861
Long line											
Motorized	2	789	987	296	2126	0	900	225	2072	4198	5323
Nonmotorized	7	0	0	1081	448	0	49	12	1081	1529	1590
Nets and lines											
Motorized	2	1357	3827	1710	0	274	543	136	7168	6894	7847
Total sample[c]											
Motorized	84	821	2491	985	711	198	778	194	4495	5008	6178
Nonmotorized	13	6	0	703	926	0	59	15	709	1635	1709

continued

Table 6. Concluded.

Region	Sample size	Variable: Cash: Labour	Variable: Cash: Fuel	Variable: Cash: Others	Variable: Opportunity of family labour	Fixed: Cash: Interest on borrowed capital	Fixed: Depreciation	Fixed: Opportunity of own capital	Total cash	Total variable	Total costs
Mindanao											
Gill net											
Motorized	11	1371	869	715	0	150	738	184	3105	2955	4027
Nonmotorized	7	145	0	123	0	162	332	83	430	268	845
Other nets											
Motorized	15	1761	630	427	0	292	952	238	3110	2818	4300
Handline											
Motorized	8	750	1671	1125	0	149	632	158	3695	3546	4485
Nonmotorized	2	0	0	300	0	0	131	33	300	300	464
Hand- and longlines											
Motorized	6	3640	2354	991	0	204	603	151	7189	6985	7943
Nonmotorized	6	0	0	1167	0	126	211	55	1293	1167	1559
Nets and lines											
Motorized	19	3189	3214	2083	73	323	922	231	8809	8559	10035
Nonmotorized	3	0	0	101	0	103	222	55	204	101	481
Total sample[d]											
Motorized	67	2020	1785	1188	21	256	807	202	5249	5014	6279
Nonmotorized	25	137	0	580	0	120	240	60	837	717	1137
Philippines											
Motorized	295	1400	3190	1860	402	231	877	219	6681	6852	8179
Nonmotorized	97	409	0	969	351	68	146	36	1446	1729	1979

[a]In 1979, 7.4 pesos (PHP) = US$1.
[b]Includes 8 miscellaneous gear types.
[c]Includes 6 miscellaneous gear types.
[d]Includes 5 miscellaneous gear types.

was computed by multiplying the number of man-days spent by family members in fishing by the minimum wage rate during that time, which was 10 PHP/man-day for the agricultural sector. Not all fishermen used family labour. There were no significant differences in the use of family labour among different boat sizes or types of gear.

Fixed costs include interest on borrowed capital, depreciation, and opportunity cost of own capital. Fixed costs accounted for 16% of total costs for motorized boats and 13% for nonmotorized.

Interest on borrowed capital is the only cash cost among fixed expenses. The value given is the interest for 1 year of operation. Because owners of many motorized boats obtained large loans, they incurred larger interest costs than nonmotorized boats. Depreciation is an imputed cost for the use of durable but depreciating capital and, in this study, the straight-line method was used in computing it. Not surprisingly, motorized boats had higher depreciation expenses than nonmotorized boats (11 vs 7% of total). The opportunity cost of own capital was imputed by using the prevailing interest rate on bank savings, which was 7.5% per year in 1979. The values imputed, therefore, were dependent on the amount of capital invested in fishing and, therefore, much larger for motorized than nonmotorized boats.

The total cash cost is the sum of all cash expenses, whether variable or fixed, incurred in the fishing operation. Cash costs constituted 81% of the total costs for all boats: 82% for motorized boats and 73% for nonmotorized boats. In absolute terms, cash costs incurred by nonmotorized boats were only about 20% of those incurred by motorized boats. Fuel alone was almost 50% of the total cash costs of motorized boats.

Adding noncash expenses (depreciation, opportunity costs of family labour, and opportunity costs of capital) to cash expenses gives the total cost. For all boat owners, the average total cost was 6645 PHP. Total expenses of motorized boats were more than four times those for nonmotorized boats. Among the regions, fishermen from Luzon incurred the highest cost both on motorized and nonmotorized boats.

Table 7. Gross revenues, income, and profit per fishing unit by gear type and location, Philippines, 1978–79.

Region	Sample size	Gross revenues (PHP)	Income (PHP)[a]		Economic profit (PHP)		Opportunity costs of management (PHP)	Pure profit or resource rent (PHP)	Return to —		
			Gross	Net	Gross	Net			Capital (%)	Management (PHP/ man-day)	Labour (PHP/ man-day)
Luzon											
Gill net											
Motorized	52	14536	4652	3514	4405	2792	5400	-2608	-76	9	6
Nonmotorized	15	6987	4689	4406	4741	4335	3228	1107	129	26	10
Baby trawl											
Motorized	19	14896	4665	3934	4530	3438	4456	-1018	-27	15	10
Other nets											
Motorized	12	15390	5319	3921	4794	2789	4512	-1723	-24	11	3
Nonmotorized	21	6698	4770	4682	3977	3799	4510	-711	-211	17	15
Hand line											
Motorized	8	10314	2219	1259	2455	1041	6626	-5585	-174	3	5
Nonmotorized	3	5138	4443	4396	4443	4384	3590	794	504	24	–
Long line											
Motorized	36	9086	3302	2558	3279	2148	3192	-1044	-27	12	13
Nonmotorized	18	6150	4341	4285	4198	4050	2754	1296	742	29	–
Nets and lines											
Motorized	10	12893	4339	3182	4048	2174	6118	-3944	-84	6	6
Total sample[b]											
Motorized	144	12789	4169	3202	4009	2562	5092	-2530	-64	9	5
Nonmotorized	59	6364	4496	4371	4183	3966	2782	1184	309	28	13
Visayas											
Gill net											
Motorized	57	5980	1397	581	771	-438	4618	-5056	-139	1	2
Nonmotorized	4	1820	1437	1350	788	-884	2450	-3334	-129	7	2
Baby trawl											
Motorized	19	5394	941	194	718	-467	4504	-4971	-144	1	2

Long line											
Motorized	2	2690	3618	282	1508	-2633	2802	-5435	2	17	12
Nonmotorized	7	4137	3056	3008	2608	2548	6354	-3806	-237	8	–
Nets and lines											
Motorized	2	8750	1582	1039	1856	903	7168	-6265	-323	2	3
Total sample[c]											
Motorized	84	5749	1254	476	741	-429	4696	-5125	-150	1	2
Nonmotorized	13	3350	2641	2582	1715	1641	4868	-3227	-1606	6	2
Mindanao											
Gill net											
Motorized	11	6759	3654	2916	3804	2732	3238	-506	-7	16	6
Nonmotorized	7	3901	3471	3139	3633	3056	2660	396	58	22	5
Other nets											
Motorized	15	5530	2420	1468	2712	1230	1912	-682	-5	10	5
Handlines											
Motorized	8	10286	6590	5958	6740	5801	5330	471	37	21	9
Nonmotorized	2	2616	2316	2185	2316	2152	4390	-2238	-501	10	–
Hand- and longlines											
Motorized	6	11423	4234	3631	4438	3480	5262	-1782	-71	13	8
Nonmotorized	5	6051	4758	4540	4884	4485	3840	645	113	23	–
Nets and lines											
Motorized	19	11040	2231	1309	2481	1005	6190	-5185	44	22	9
Nonmotorized	3	4435	4231	4009	4334	3954	4096	-142	-142	14	–
Total sample[d]											
Motorized	67	10390	5141	4334	5376	4111	4616	-505	-2	11	7
Nonmotorized	25	4314	3477	3237	3597	3177	3364	-187	-1	19	4
Philippines											
Motorized	295	10240	3559	2682	3388	2061	4870	-2809	-81	8	5
Nonmotorized	97	5432	3986	3840	3703	3453	3212	241	72	21	10

[a]In 1979, 7.4 pesos (PHP) = US$1
[b]Includes 8 miscellaneous gear types.
[c]Includes 6 miscellaneous gear types.
[d]Includes 5 miscellaneous gear types.

Revenues and Incomes

The gross revenues are the proceeds from fish sales and averaged about 9050 PHP per fishing unit (Table 7) with the owners of motorized boats receiving twice as much as those of nonmotorized boats. Fishermen from Luzon received the highest proceeds followed by fishermen in Mindanao. The sequence was the same for owners of motorized and nonmotorized boats.

Usually owners of motorized boats had higher revenues compared to nonmotorized boat owners. In a few instances, however, the reverse occurred. Longline users within the 0.50–0.75 GT category in the Visayas, for example, received 3780 PHP if boats were motorized whereas incomes from nonmotorized boats were 46% higher. The reason for this was the low fishing effort by the motorized boat owners (averaging 67.5 man-days for the whole year) compared with almost five times as much by owners of nonmotorized boats (333 man-days).

By deducting expenses from revenues, income is computed and, depending on the type of expense deducted, different measures of income can be obtained (Table 7).

Gross income is obtained by deducting cash expenses from the total revenue. For the Philippines as a whole, gross income of fishermen amounted to 3664 PHP. It should be noted that gross income is not a sustainable level of income because it does not make provision for replacement of equipment and other fixed assets.

It is interesting to note that the average gross income of owners of nonmotorized boats was higher than that for motorized boats. Although catch by motorized boats was 89% higher than that of nonmotorized boats, the expenses were three times as high. In addition, motorized boats had greater depreciation costs. Thus, the nonmotorized boats seemed to do better. This has serious implications with respect to policies on motorization. The gross income of nonmotorized boats was more than twice that of motorized boats in the Visayas. The difference in Luzon was relatively small but still in favour of nonmotorized boats; the reverse occurred in Mindanao where gross income was almost 50% higher for motorized boats. Further research to examine the significance of these differences in incomes of motorized and nonmotorized boats is needed.

Fishermen from the Visayas received an annual gross income of 1440 PHP, which was considerably below the national average. Mindanao fishermen did better, earning 4689 PHP/year. Although fishermen from Luzon realized the highest gross revenue, 10922 PHP, they earned a gross income of only 4264 PHP because of their high cash expenditures.

For motorized boats in the Visayas, the use of a combination of nets and lines was most profitable giving a gross income of 1582 PHP/year. Among nonmotorized boats in general, handlines yielded the highest gross income, 5822 PHP. Only boats of 0.50–0.75 GT were represented here and no motorized boat counterpart was reported in this category.

In Mindanao, owners of motorized boats had larger gross incomes than those of nonmotorized boats. For them, the use of a combination of handlines was most rewarding giving a gross income of 6590 PHP for motorized boats. On the average, the larger the boat was, the higher the gross income.

To sustain a certain income over the long run, plans must be made for purchasing new assets, particularly boat and gear, hence depreciation costs should be subtracted from gross income. This gives net income that, in effect, reflects return to capital and to family labour. In general, the same relationships as that for gross income were observed in the analysis of net income (Table 7). Differences between motorized and nonmotorized boats were more marked because of the greater depreciation costs of the former. For the Philippines as a whole, nonmotorized boats yielded a higher net income than motorized boats. In Luzon, gill nets and longlines in nonmotorized boats had a relatively higher net income. In absolute terms, net income in Luzon was far greater than in the Visayas.

Economic Profit and Returns to Factors of Production

If total variable costs are deducted from total revenues, gross economic profit results, whereas if all expenditures — variable and fixed — are deducted, net economic profit is obtained.

On the average, a fisherman received a gross profit of 3466 PHP, but incurred noncash expenses, which, if deducted, resulted in a net economic profit of 2405 PHP. Again, nonmotorized boats obtained a higher net economic profit (by 67%) than motorized boats. This occurred because the latter had higher depreciation, hired labour, and opportunity costs of capital that further enlarged the difference in profit between motorized and nonmotorized boats.

In several instances, the values of net economic profit were negative, especially in the Visayas. This negative profit, however, may not have been felt directly by the fishermen, as long as they were earning a living. This is the reason why they later face the need to borrow to replace their worn-out fishing assets.

Owners of nonmotorized boats from Luzon realized an average net economic profit of 3966 PHP, which was 55% higher than for motorized boat owners. Among owners of motorized boats in the same region, baby trawl users had the highest economic profit, amounting to an average of 3438 PHP: in particular, those using boats of 0.76–1.00 GT fared well with net economic profit of 4737 PHP.

In the Visayas, the average net economic profit for all owners of motorized boats was negative (-429 PHP) signifying that the total costs of operations exceeded revenues. Negative net economic profits were predominant for fishing units using gill net, baby trawl, and longline. Net economic profit should be positive or at least equal to zero to sustain fishing operations in the long run. If all costs cannot be covered by the revenues, a firm (fishing unit) would, in theory, sell its capital assets and invest the money in more profitable activities.

The types of gear that provided the highest revenues and gross income also had the highest gross and net economic profits. The use of a combination of handline and longline by owners of nonmotorized boats gave rise to the highest net economic profit, 4485 PHP, of all gear types. Fishing units using smaller boats, 0.50 GT, generally had higher net profits within a particular gear category.

Finally, pure profit or resource rents can be obtained by deducting the opportunity cost of management from the net economic profit. Because it is not a common practice to hire a boat manager or captain of a fishing unit in the municipal fisheries, the value for wage assigned for 1 man-day of work of the operator was imputed using twice the minimum wage rate for the agricultural sector, 10.00 PHP at the time of the survey. For the country as a whole, resource rents were negative for motorized boats, -2809 PHP, and positive but low for nommotorized boats, 241 PHP. Regionally, resource rents were positive only for nonmotorized boats in Luzon. Gill nets and longlines, and to a lesser extent handlines, operated by nonmotorized boats enjoyed positive resource rents; all other types of gear incurred losses, which imply considerable economic overfishing.

Return to capital was taken as the sum of pure profit, opportunity cost of own capital, and interest on borrowed capital expressed as a percentage of the current value of fishing assets. For the country as a whole, the average return to capital was much higher for nonmotorized boats, 72%, than for motorized boats, -81%, as the former had a much lower value of assets and larger profits.

As we have seen above, pure profit for many fishermen was negative. This simply means that fishermen as entrepreneurs were actually earning an income below the opportunity cost of management. Thus, return to management was frequently below 10 PHP/man-day. On the average, however, owners of nonmotorized boats received higher return to their management than those of motorized boats (21 vs 8 PHP/man-day). Hired labour also received a lower remuneration on motorized boats than on nonmotorized boats (5 vs 10 PHP/man-day).

Conclusions and Policy Implications

In the light of the low incomes prevailing in the fisheries sector, the government should take steps to improve the performance of the industry. Moreover, the government must seek ways of advancing the socioeconomic conditions of small-scale fishermen.

Although motorization does lead to larger catches and larger gross receipts, the findings of this study suggest that nonmotorized boats yield a greater net income than motorized boats. This is explained by the higher cash costs, particularly fuel, and the higher depreciation of motorized boats.

Although there is no definite evidence of biological overfishing, the negative net economic profits of fishermen indicate economic overfishing and the volume of catch of fishermen appears to have declined over time. The problem of overfishing necessitates policies on fisheries resources management. Such policies could aim at a number of objectives, such as maximum sustainable yield, maximum economic yield, provision of employment opportunities, and increased efficiency of fishermen. These objectives conflict with each other. As mentioned earlier, the fishermen's catch can be increased via technological improvement, but improvements in economic efficiency could well mean a reduction in fishing effort and a slowdown in motorization and technological improvements.

Within the municipal fishery itself, entry is not restricted except for certain imposed requirements, e.g., licensing of boats, although payment is minimal. Uncontrolled entry into the industry could lead to overexploitation of fishery resources. Under such conditions, increased motorizaton of boats could increase catch but possibly at the expense of other fishermen and of the fishery's overall sustainable catch. It is important, therefore, that fishing resources be managed properly. Fisheries management could take the form of controlling fishing effort.

Control of fishing intensity limits the entry of fishermen into the industry either in terms of the numbers of boats or of gear employed. The number of licenses issued should be limited to a certain predetermined level that considers biological, social, economic, and political factors.

Fishing usually is not a full-time activity and fishermen and family members supplement their meager fishing income with other income-generating activities. Programs to encourage alternative income sources are therefore important.

Fisheries must be viewed as part of the larger rural economy. At present, the natural rate of growth of rural population is generally higher than that of the urban population and government policy has been to disperse industries and the Metro Manila population to the provinces. It is expected that the expansion in the rural population will continue, thus raising the policy issue of employment prospects not only for the nonfarming-nonfishing households but also for the whole agricultural and fisheries sectors as well. Moreover, a reverse urban-rural migration trend implies an increased number of households engaged in fishing. This means continued strong pressure on the open-access fishing resources and persistence of poverty (Smith et al. 1980). This transformation and the need to slow down rural-urban migration suggest that solutions to the problem of poverty must be found in development programs aimed at the rural sector as a whole. Policies must recognize the totality of the environment of the fishermen and the complementarity between fishing and other aspects of this environment, including agriculture and other nonfishing activities.

Appendix: Types of Catching Gear Used by Fishermen in the Philippines[2]

Lines — long lines of abaca (Manila hemp), cotton, or nylon twine with a series of baited hooks.

- Longlines — extremely long lines with a large series of baited hooks, either set or drifting and requiring only periodic attention at more or less fixed intervals. They usually employ 50 to several hundred small hooks, the number depending on the length of line, size of hooks, species intended to be caught, and bait to be used.
- Handlines — simple lines rolled on bamboo sticks having only one to four baited hooks on the end. Bigger hooks and stronger and heavier lines than longlines are usually used, and constant attention is required. Intended catch is the bigger species such as tuna and sailfish.

Gill nets — curtain-like nets in which the fish are captured by the actual mesh of the net: the neck or pharyngeal part of the fish is caught between the meshes, hence the name gill net. This type of net is, therefore, size specific and the bigger the mesh, the bigger the fish caught. Gill nets can be stationary or drifted by boat and can be set horizontally in the upper or lower layers of the water.

Lift nets — nets in which capture is effected by a vertical motion of the gear.

- Push nets — triangularly formed, collapsible nets operated by one man where the capture is effected by a forward, horizontal (pushing) motion along the bottom of shallow water within wading depths.
- Crab lift nets — framed, shallow lift nets that are baited, sunk to the bottom on lines, and, once in a while, hauled suddenly to the surface, therefore requiring periodic attention.

Seine nets — the net consists of a bunt or bag, flanked on each side by quarters and wings. The apparatus is "shot" in such a position as to enclose a definite body of water that contains a school of fish, thereby localizing it. The net is then hauled toward shore or to a vessel.

Fish corrals — these are guiding barriers consisting of one or more enclosures with a leader, wings, and gates that are arranged so that migratory fishes are led easily into the trap without any chance of escape.

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[2]Adapted from Umali (1950).

Cost Structure and Profitability of the Thai Coastal Fishery

Theodore Panayotou, Thanwa Jitsanguan, and Kamphol Adulavidhaya

The Thai fishing industry, which today is one of the top 10 fisheries in the world, only two decades ago was no more than a subsistence sector using primitive technology, such as lift nets, cast nets, and traps. The introduction of trawlers and other modern technology since the early 1960s has revolutionized the profile and structure of the Thai fishery. In a few years, an industrial fleet was developed, fishing grounds were expanded to the coasts of China and India, and production and exports rose steeply. The phenomenal profits generated in the process were reinvested into more advanced and improved technology. The massive entry into the fishery since the early 1960s and its continuation at present, despite a few lapses in reaction to the oil crisis, are reflections of the income-generating capacity of the industry.

However, coastal fishermen, who still account for over 70% of all fishermen in Thailand, are still considered among the lowest-income groups in the country. Many of them continue to use the same primitive technology they have been using for decades, if not for centuries. Their conditions have been ignored until very recently, presumably on the expectation that they would either adopt the new technology or find employment in the rapidly expanding industrial fishery: at worst, they could always switch to some other occupation. However, the lack of investment funds and credit, combined with the capital-using, labour-saving bias of the new fishing technology and the increasing unemployment in the rest of the economy, served to frustrate these expectations.

Because the government is now increasingly interested in providing development assistance to coastal fishermen, but pertinent information is lacking, it is necessary to determine their true socioeconomic conditions.

Our socioeconomic study (Panayotou et al., this volume, p. 55) concluded that the coastal fishermen sampled in different locations had widely divergent fishing incomes. It is further suspected that the income variances among fishing units within the same location are sufficiently substantial to warrant a closer look and a more objective calculation of fishing incomes based on a cost-and-earnings study.

Thus the objective of the study reported here was to determine and compare the cost structure and profitability of the various types of fishing technology employed in different locations and determine which ought to be promoted and which to be discontinued or converted. A related objective was to determine the distribution of the earnings from fishing among the boat owner, the crew members, and other factors of production under different types of technology and from this to derive pertinent policy implications.

The study is based on the same sample data used in the socioeconomic study, that is, cross-sectional figures pertaining to 1978 and obtained through the "recall method" from coastal fishermen in four Thai provinces — Chumporn, Nakhon Si Thammarat (referred to as Nakhon), Pang Nga, and Trat (for further details see the Thai socioeconomic study, this volume, p. 55).

Typology of Gear and Definition of Scale

Fishing units are classified by type of technology or fishing gear employed and ranked in the reverse order of the current value of their fishing assets (Table 1). Fishing units using more than one type of fishing gear form separate groups of combined gear and are treated as a separate technology. Gear groups with fewer than three fishing units were lumped into "miscellaneous single" or "miscellaneous combined" gear groups depending on whether one or more types of gear were used.

On these criteria, we identified 15 gear groups in Chumporn, 11 in Nakhon, 15 in Pang Nga,

Table 1. Cost structure, debt, and current capital cost by selected types of technology in four coastal provinces, Thailand, 1978.

Type of gear	Sample size	Current capital cost (THB)[a]	Debt Amount (THB)	Debt Interest (THB)	Debt % of capital cost	% of total cost: Fixed cost	Labour cost	Fuel cost	Other cost
Chumporn									
Small-scale									
Cast net	42	7623	1552	36	20.4	13.3	42.3	19.8	24.6
Shrimp gill net	9	7810	11556	36	148.0	19.6	32.5	10.5	37.4
Crab gill net	7	9113	4571	36	50.2	17.1	45.9	12.6	24.4
Medium-scale									
Fish gill net	32	24501	19265	36	78.6	10.8	38.7	20.7	29.8
Push net	17	38788	7782	36	20.1	21.0	20.6	33.2	25.2
Purse seine	13	44900	35423	36	78.9	6.6	49.5	7.9	36.0
Trawl net	17	60277	14441	36	24.0	16.3	24.0	25.2	34.5
Nakhon									
Small-scale									
Lift net	34	4585	2425	52	52.9	15.6	42.5	16.1	25.8
Winged set bag	9	8622	3489	37	40.5	26.5	21.6	21.3	30.6
Shrimp gill net	44	10739	3323	36	30.9	12.3	37.6	16.2	33.9
Trawl net	67	11231	5573	63	49.6	18.9	16.6	45.9	18.6
Medium-scale									
Push net	40	25454	8750	42	34.4	15.8	20.5	41.3	22.4
Pang Nga									
Small-scale									
Nonpowered	29	1643	482	11	29.3	1.6	46.1	6.7	45.6
Push net	8	4276	1000	8	23.4	6.2	53.4	20.7	19.7
Winged set bag	20	4385	1095	10	25.0	10.0	38.4	22.5	29.1
Crab gill net	35	6103	795	10	13.0	9.2	29.3	25.7	35.8
Shrimp gill net	32	9808	781	11	8.0	11.2	50.2	20.0	18.6
Trat									
Small-scale									
Crab trap	20	6855	1150	12	16.8	5.9	54.9	18.7	20.5
Fish gill net	4	4875	2250	–	46.2	4.5	12.7	8.3	74.5
Shrimp gill net	7	13372	10714	11	80.1	9.6	26.0	16.7	47.7
Crab gill net	43	13590	5580	13	41.1	9.1	31.7	12.6	46.6
Medium-scale									
Push net	12	58833	8333	13	14.2	15.5	27.6	41.8	15.1
Trawl net	6	68166	27500	21	40.3	12.0	28.2	47.5	12.3

[a]US$1 = 20.40 baht (THB).

and 9 in Trat. (For brevity, only selected single gear groups are analyzed in detail in the present study; gear combinations and miscellaneous types, however, are included in the aggregate tables). Although certain types of gear were common in two or more locations, most were location specific. Only two gear groups, shrimp gill net and push net, were present in all four provinces, and one gear group, the trawl, was encountered in all provinces except Pang Nga. Crab gill net and fish gill net were employed only in the two more-developed fisheries, Chumporn and Trat, whereas winged set bag, a stationary gear, was employed only in the more primitive fishery of Pang Nga.

The various gear groups were further classified into two broad categories according to the average current value of fishing assets owned by the economic units (households) belonging to the group. Gear groups with fishing assets valued at less than 20000 THB in 1978–79 were classified as small-scale and those with more than 20000 THB were classified as medium-scale[1] (in 1980, 20.40 baht [THB] = US$1). No large-scale fishing units (with assets exceeding 100000 THB) were surveyed. The dividing line between these groups is admittedly arbitrary, as

[1]The Thai Department of Fisheries' (1979) use of length of vessel in defining scale (less than 14 m is small scale and over 14 m is large scale) may be satisfactory for a broad classification but is a poor indicator of scale within the small-scale group.

it would be with any other criterion of "scale" such as length or tonnage of vessel, or horsepower of engine. However, because of the multiplicity and overlap of physical characteristics, no one-to-one correspondence between these characteristics and scale of operations could be established. The use of "long-tail" boats (long, narrow, canoe-like craft fitted with outboard motors) and used-car engines of high horsepower are cases in point. In contrast, there is a one-to-one correspondence between scale and capital cost or current value of assets. The latter constitutes an overall index of the physical characteristics of the fishing unit assuming no significant differentials in the cost of the same asset among locations.

The reasons behind the choice of current value of assets over the initial cost or purchase price of boat and engine are:

- These two fishing assets have different economic lives and as a consequence their times of purchase do not always coincide, and
- Different fishermen had purchased their fishing assets at different times and made varying improvements since.

These reasons, coupled with a high rate of inflation, made it necessary to establish a common time of reference for all fishing units. The time of the survey (referred to as the current year) was chosen both for convenience and because of economic meaning: if the fishermen had liquidated their assets at the time of the survey, they would have obtained the current value of their assets — the fact that they had not done so means either that they have been earning a satisfactory rate of return (the opportunity cost of assets) or that noneconomic constraints were present.

The choice of 20 000 THB as the dividing line between small-scale and medium-scale fishing units was based on the observation that there was an abrupt discontinuity in the current value of assets. In Chumporn and Nakhon, the average current value of assets by gear group jumped from 15 000 to 25 000 THB and in Trat the discontinuity was even more striking, from 12 000 to 42 000 THB (Table 2).

According to this criterion, about 50% of the fishing units surveyed in Chumporn, 65% in Trat, 85% in Nakhon, and 100% in Pang Nga were small-scale fishing units averaging 7640 THB in current value of assets. In contrast, the medium-scale fishing units, 17% of the total sample of 769 coastal fishing households, averaged a current value of assets as high as 43 400 THB. (This may be compared to the Thai Department of Fisheries [1979] classification of "small-scale" otter trawlers, less than 14 m in length, which averaged 59 300 THB in 1977 value of assets.) Thus the precipitous dualism observed between coastal fishermen and industrial (offshore and distant-water) fisheries is also observed within the coastal fishery itself. Just for comparison, the 1977 value of assets of the large-scale trawlers, both by the Department of Fisheries' and our definitions of scale, was 352 900–4 227 000 THB (Panayotou 1980b).

Capital Cost, Debt, and Variable Input Use

The current value of fishing assets (boat and engine) is given in Tables 1 and 2 with indebted-

Table 2. Cost structure, debt, and current capital cost by scale of operation in four coastal provinces, Thailand, 1978.

Location	Sample size	Current capital cost (THB)[a]	Debt: Amount (THB)	Debt: Interest (THB)	Debt: % of capital cost	% of total cost: Fixed cost	% of total cost: Labour cost	% of total cost: Fuel cost	% of total cost: Other cost
Chumporn	**176**	**23555**	**10893**	**34**	**46.2**	**12.0**	**38.9**	**17.0**	**32.1**
Small-scale	87	8232	3904	33	47.4	17.6	37.8	15.9	28.7
Medium-scale	89	38534	17724	36	46.0	11.3	39.0	17.2	32.5
Nakhon	**275**	**11244**	**4410**	**51**	**39.2**	**15.9**	**26.4**	**33.4**	**24.3**
Small-scale	235	8825	3671	52	41.6	15.6	28.8	30.4	25.2
Medium-scale	40	25454	8750	42	34.4	15.8	20.5	41.3	22.4
Pang Nga	**229**	**4600**	**911**	**10**	**19.8**	**7.6**	**40.6**	**21.7**	**30.1**
Small-scale	229	4600	911	10	19.8	7.6	40.6	21.7	30.1
Medium-scale	0	–	–	–	–	–	–	–	–
Trat	**128**	**26226**	**7139**	**12**	**27.2**	**9.5**	**33.0**	**32.8**	**24.7**
Small-scale	86	12201	4449	11	36.5	8.3	35.2	13.7	42.8
Medium-scale	42	54945	12646	13	23.0	10.0	32.1	41.5	16.4

[a]US$1 = 20.40 baht (THB).

ness and cost structure. Table 1 presents the information for selected types of fishing gear and Table 2 presents the aggregate picture by scale of operation. Small-scale fishing units averaged a current value of assets of 4600–12 200 THB and the medium-scale units averaged 25 500–55 000 THB. In the two more-developed areas, Trat and Chumporn, the average value of assets of the medium-scale fishery was almost five times that of the small-scale fishery. The highest value assets (39 000–68 000 THB) were trawlers and push nets in Trat and trawlers, purse seines, and push nets in Chumporn; the lowest in value, 1600 THB, were the non-powered gears in Pang Nga.

Not all capital for the purchase and repair of fishing assets was obtained from owned sources. Virtually all groups, both small-scale and medium-scale units, had debts with the single exception of the combined cast net and shrimp gill net. Although in absolute amounts, medium-scale gear groups had, on the average, larger debts than smaller-scale, in relation to the value of their assets they had borrowed about the same percentage. Only in Trat was debt not in proportion with the value of assets for these two broad categories of fishing units (small-scale 51% and medium-scale 28% of capital). Within each category, however, there is no discernible relationship between ownership of assets and debt for the simple reason that, although larger fishing units need more funds to finance their investment, they also tended to be more profitable in generating internal funds. Purse seines in Chumporn had the highest amount of debt, 35 400 THB, followed by trawlers in Trat, 27 500 THB (Table 2). Among the small-scale fishing units, the ones with the highest debt were combined gill nets in Chumporn, 20 000 THB, and shrimp gill nets in both Chumporn and Trat, around 11 000 THB. No gear group in Pang Nga owed more than 1100 THB/fishing unit and the average debt for the fishery as a whole was less than 1000 THB/fishing unit, to be compared with an average of 4400–11 000 THB for the other three provinces (Table 2).

On the average, the highest interest rates (51%) were paid by the fishermen in Nakhon, who had borrowed from noninstitutional sources such as middlemen, fish merchants, and relatives. Next came Chumporn with an average interest rate of 34%, where only three gear groups had borrowed money at the institutional rate of 12%. Virtually all fishermen in Trat had borrowed at the institutional rate. Fishermen in Pang Nga also paid interest rates in the neighbourhood of the institutional rate, average 10% per year, although they borrowed mostly from noninstitutional sources. Recalling that all sampled fishermen from Pang Nga were Muslims, we may theorize that religious reservations about lending for interest may be responsible for both the low interest rates charged and the small amounts borrowed. It is also worth noting that we found no significant difference in the cost of borrowing between small- and medium-scale gear groups (Table 2).

The main variable inputs used were labour, nets, and fuel, with the operator's household being the main source of crew. In Pang Nga, with the notable exception of the two groups of relatively larger fishing units, no hired labour was used. On the average, small-scale fishing units used less hired labour than those of medium scale, and there was no significant difference in family labour among the two groups: small- and medium-scale gear alike averaged 1.5 persons/fishing unit in all locations, except for medium-scale gear in Chumporn, which averaged 2.3 family members/fishing unit. In terms of 8-hour working days (man-days), there were no regular or significant differences related to scale, except for Trat where small-scale units used only 18 man-days/month compared with 27 man-days by medium-scale units. There were, however, significant differences in man-days of family labour within each scale category and even wider differences between locations: the average fishing unit in Pang Nga used only 17 man-days of family labour per fishing month (a reflection of the availability of nonfishing employment) compared with 35 man-days used in Chumporn. Households in Nakhon and Trat used, on the average, 32 man-days of family labour per month. (The calculated man-day values for all provinces except Pang Nga were considerably higher than those obtained through direct questioning of the fishermen and reported in our socioeconomic study; this volume, p. 55.)

The consumption of fuel was positively correlated with horsepower (correlation coefficient 0.754 for Chumporn) and length of boat (0.643) but negatively correlated with current value of assets at least for Chumporn (-0.501). The largest consumers of fuel were the medium-scale fishing units of Chumporn, 2650 L/fishing month, and the lowest were the small-scale units of Pang Nga, 77 L/fishing month.

Cost Structure

Fixed costs, that is, costs that do not depend on the level of operation but on the value of fishing assets, ranged between 2% of total costs for nonpowered units in Pang Nga and 5% for fish gill net in Trat to 27% for winged set bag in Nakhon (Table 1), all of which were small-scale types of gear. On the average, there was no significant difference in the share of fixed costs between small- and medium-scale operations (Table 2); more important in this respect were differences among locations, the fisheries of Chumporn (fixed cost share 12%) and Nakhon (16%) being relatively more capitalized than those of Trat (9%) and Pang Nga (8%). The generally low share of fixed costs in total costs meant that only a small part of the total fishing costs was unavoidable and independent of the level of operation.

Of the variable-cost items, which ranged between 73 and 98% of total fishing costs for individual gear groups, fuel was the main cash-cost item and accounted for between about 7% of total costs in the case of nonpowered gear to as much as 48% in the case of trawl in Trat. It was generally true that fuel accounted for a higher percentage of total costs among medium- than among small-scale fishing units. The latter were generally more labour-intensive than medium-scale units although they hired little labour outside their immediate family. In Pang Nga, for instance, where only small-scale fishing gears were found, 100% of the labour employed was drawn from the family (with the exception of shrimp gill net). The most labour-intensive types of gear were crab trap in Trat and push net and shrimp gill net in Pang Nga with a labour cost share of over 50% of total fishing costs. Purse seines in Chumporn are also worth noting: despite their size, they were labour intensive in the sense that 50% of their total costs were accounted for by explicit and implicit payments to labour whereas only 8% were accounted for by fuel. In contrast, trawlers in all locations were fuel- rather than labour-intensive. As expected, nonpowered gears use little fuel and a great deal of labour, usually from the family. Considering location, in Trat and Nakhon, the cost structure of the fisheries was dominated by fuel (33%), whereas in Chumporn and Pang Nga labour was the dominant cost (around 40%).

The implication of the prevailing cost structure is that cheap-fuel or cheap-labour policies favour the medium-scale fishermen who use relatively more of both inputs than small-scale fishermen who use mainly family labour and relatively little fuel. This explains why the calls for cheaper fuel, ostensibly to save the small-scale fishermen, come mainly from medium- and large-scale operators rather than from the small-scale fishermen: although the latter would no doubt benefit at least temporarily if cheaper fuel were available. Small-scale fishermen, however, would benefit relatively more from expansion in institutional credit. Small-scale fishermen in Chumporn and Nakhon, having debts of up to 148% of their capital cost and paying interest rates of 36–63% would benefit considerably if they could borrow at the institutional rate of 8–12%. A cheap labour policy, on the other hand, although it would not benefit small-scale fishermen or crewmen directly, might encourage

Table 3. Major cost items (THB/month)[a] per fishing unit by scale of operation in four coastal provinces, Thailand, 1978.

Location	Sample size	Fixed costs: Cash cost: Interest on debt	Fixed costs: Depreciation	Fixed costs: Opportunity cost of capital	Variable costs: Cash cost: Labour	Variable costs: Cash cost: Fuel	Variable costs: Cash cost: Other	Variable costs: Opportunity cost of family labour	Total: Cash cost	Total: Imputed cost	Total: Total cost
Chumporn	**176**	**495**	**386**	**451**	**2037**	**1880**	**3546**	**2258**	**7958**	**3095**	**11053**
Small-scale	87	179	149	161	14	443	798	1037	1434	1347	2781
Medium-scale	89	805	619	734	4015	3285	6231	3452	14336	4805	19141
Nakhon	**275**	**265**	**83**	**198**	**290**	**1145**	**834**	**613**	**2534**	**894**	**3428**
Small-scale	235	224	67	156	258	870	722	565	2074	788	2862
Medium-scale	40	432	174	449	476	2758	1497	889	5163	1512	6675
Pang Nga	**229**	**10**	**50**	**69**	**52**	**368**	**496**	**635**	**926**	**754**	**1680**
Small-scale	229	10	50	69	52	368	496	635	926	754	1680
Medium-scale	0	–	–	–	–	–	–	–	–	–	–
Trat	**128**	**108**	**369**	**393**	**1502**	**3012**	**2263**	**1531**	**6885**	**2293**	**9178**
Small-scale	86	49	152	154	232	586	1830	1270	2697	1576	4273
Medium-scale	42	229	813	882	4103	7981	3149	2065	15462	3760	19222

[a]US$1 = 20.40 baht (THB).

the employment of more labour especially by medium- and large-scale fishing units. However, a more appropriate policy would be the correction of factor market distortions (such as tax privileges for large-scale investments and minimum wage laws) that implicitly subsidize capital at the expense of labour.

Fixed costs consist of interest on debt, depreciation of fishing assets, and the opportunity cost of owned capital. Variable costs consist of payments to hired labour, fuel, opportunity cost of family labour, and "others" (mainly nets, ice, fees, and maintenance). Total cost and its component elements vary considerably among locations, types of gear, and scales of operation (Tables 3 and 4). Medium-scale fishing units in Chumporn and Trat averaged a total cost of almost 20000 THB/fishing month whereas small-scale units ranged between 1700 THB in Pang Nga and 4300 THB in Trat. Purse seines in

Table 4. Major cost items (THB/month)[a] per fishing unit by selected types of technology in four coastal provinces, Thailand, 1978.

		Fixed costs			Variable costs				Total		
		Cash cost			Cash cost			Opportunity cost of family labour			
Location	Sample size	Interest on debt	Depreciation	Opportunity cost of capital	Labour	Fuel	Other		Cash cost	Imputed cost	Total cost
Chumporn											
Small-scale											
Cast net	42	74	127	152	0	528	647	1137	1249	1416	2665
Shrimp gill net	9	507	95	143	0	400	1419	1233	2326	1471	3797
Crab gill net	7	208	204	173	85	432	748	1568	1473	1945	3418
Medium-scale											
Fish gill net	32	925	366	490	2817	3401	4904	3542	12047	4398	16445
Push net	17	369	935	765	350	3277	2287	1671	6483	3371	9854
Purse seine	13	1771	873	935	17260	4280	19569	9683	42880	11491	54371
Trawl net	17	626	727	1089	1825	3768	5166	1764	11385	3580	14965
Nakhon											
Small-scale											
Lift net	34	173	33	94	111	311	498	709	1093	836	1929
Winged set bag	9	193	96	193	0	388	557	392	1138	681	1819
Shrimp gill net	44	134	86	181	498	529	1107	722	2268	989	3257
Trawl net	67	413	97	198	265	1714	695	354	3087	649	3736
Medium-scale											
Push net	40	432	174	449	476	2758	1497	889	5163	1512	6675
Pang Nga											
Small-scale											
Nonpowered	29	6	3	8	0	70	474	479	550	490	1040
Push net	8	7	36	59	0	342	325	882	674	977	1651
Winged set bag	20	13	61	77	0	339	437	578	789	716	1505
Crab gill net	35	8	57	92	0	439	610	500	1057	649	1706
Shrimp gill net	32	8	84	132	288	398	370	713	1064	929	1993
Trat											
Small-scale											
Crab trap	20	11	73	95	126	570	625	1548	1332	1716	3048
Fish gill net	4	0	92	112	110	372	3355	462	3837	666	4503
Shrimp gill net	7	157	312	195	0	1155	3310	1809	4622	2316	6938
Crab gill net	43	63	138	138	0	472	1742	1187	2277	1463	3740
Medium-scale											
Push net	12	111	661	909	1900	4531	1644	1092	8186	2662	10848
Trawl net	6	491	1219	813	3604	9975	2592	2308	16662	4340	21002

[a]US$1 = 20.40 baht (THB).

Chumporn with an average total cost of 54 000 THB/month and nonpowered gear in Pang Nga with 1040 THB/month were the gears with the highest and lowest totals. This is one more sign of the precipitous dualism of the Thai fishery: one coastal type of gear has monthly expenses over 50 times higher than another coastal gear — as noted later, the latter is several hundred times more profitable than the former, although profitability is not always correlated with the scale of operations as reflected in total fishing costs or in the capital cost of the fishing assets. The implication is that no general conclusions can be drawn about the coastal fishery of Thailand: analysis by location, type of gear, and scale of operations is necessary.

Species Composition of Catch and Revenue Structure

Because of the multispecies nature of the Thai fisheries and the nondiscriminating gear employed, the catch consists of such a great variety of species commanding such widely diverging prices that aggregate catch figures make little sense. What is the meaning of 1000 kg of catch when it consists of as many as 200 species ranging in value from less than 1 THB/kg for clams to as much as 150 THB/kg for shrimp? Although total value of catch is more meaningful than quantity, an indication of which species contribute most to this value, as well as the individual catch and unit price of these more important species, would be valuable.

Coastal fishermen directed their effort toward high unit-value species such as shrimp, crab, and mackerel but, because of the nature of the resource and the technology, they obtain as by-catch low-value species such as mysis and trash fish. There is considerable variation among gear groups in both the catch of individual species per fishing month and the price obtained. Medium-scale units catch, on the average, larger quantities and obtain lower prices than small-scale fishermen do for the same species. Moreover, the former's less valuable catch, such as trash fish, contributes sufficiently to total revenues to be considered more of a target catch than a by-catch. For example, trash fish contributed almost 25% of the total value of catch for fish gill net in Chumporn and 17% for trawl in the same province. In Chumporn, the major species in terms of value were squid (40%) and pink shrimp (34%) for the small-scale fishery and Indopacific mackerel (48%) and trash fish (15%) for the medium-scale fishery. In Trat, the major species were crab (70%) for small-scale units and pink shrimp (28%) and shellfish (25%) for medium-scale, whereas shrimp was the dominant species in both Nakhon and Pang Nga.

Fishing Incomes and Profits

As expected, the value of catch, or gross revenue, of medium-scale units was, on the average, several times the revenue of small-scale units (Table 5). Purse seines in Chumporn had by far the highest revenues, 122 000 THB/fishing month, followed by trawlers in Trat, 57 000 THB (Table 6). The lowest gross revenues were observed among the traditional fishing

Table 5. Profitability (THB)[a] per fishing unit by scale of operation in four coastal provinces, Thailand, 1978.

Location	Gross revenues (monthly)	Family income				Economic profit				Resource rents (monthly)
		Gross		Net		Gross		Net		
		Monthly	Annual	Monthly	Annual	Monthly	Annual	Monthly	Annual	
Chumporn	**18435**	**10477**	**81721**	**10089**	**76506**	**8714**	**67969**	**7380**	**57580**	**6744**
Small-scale	4835	3401	25845	3252	24715	2543	19327	2054	15610	1418
Medium-scale	31729	17393	137405	16773	123937	14746	116693	12588	99445	11952
Nakhon	**4481**	**1947**	**16549**	**1864**	**15844**	**1599**	**13591**	**1039**	**8831**	**549**
Small-scale	3903	1829	15546	1762	14977	1488	12648	1041	8848	551
Medium-scale	7701	2538	21573	2364	20094	2081	17688	1026	8721	536
Pang Nga	**3533**	**2594**	**25681**	**2544**	**25187**	**1969**	**19493**	**1853**	**18344**	**1143**
Small-scale	3533	2594	25681	2544	25187	1969	19493	1853	18344	1143
Medium-scale	–	–	–	–	–	–	–	–	–	–
Trat	**14871**	**7986**	**86249**	**7617**	**82264**	**6563**	**70880**	**5693**	**61484**	**4548**
Small-scale	5276	2579	28369	2427	26697	1358	14938	1003	11033	-142
Medium-scale	34519	19057	200098	18244	191562	17221	180820	15297	160618	14152

[a]US$1 = 20.40 baht (THB).

Table 6. Profitability (THB/month)[a] per fishing unit by selected types of technology in four coastal provinces, Thailand, 1978.

Type of gear	Gross revenue	Family income		Economic profit		Opportunity cost of management	Pure profit (economic rent)
		Gross	Net	Gross	Net		
Chumporn							
Small-scale							
Cast net	5123	3874	3747	2811	2458	636	1822
Shrimp gill net	7011	4685	4590	3961	3214	636	2578
Crab gill net	3738	2265	2061	905	320	636	-316
Medium-scale							
Fish gill net	22610	10563	10197	7956	6165	636	5529
Push net	11480	4997	4062	3695	1626	636	990
Purse seine	121830	78950	78067	71038	67449	636	66813
Trawl net	13108	1723	996	585	-1857	636	-2493
Nakhon							
Small-scale							
Lift net	2811	1718	1685	1182	882	490	392
Winged set bag	1992	854	758	665	173	490	-317
Shrimp gill net	4719	2451	2365	1863	1462	490	972
Trawl net	4490	1403	1306	1462	754	490	264
Medium-scale							
Push net	7701	2538	2364	2081	1026	490	536
Pang Nga							
Small-scale							
Nonpowered	1885	1335	1332	862	845	710	135
Push net	1362	688	652	-187	-289	710	-999
Winged set bag	3040	2251	2190	1676	1535	710	825
Crab gill net	2771	1712	1655	1220	1063	710	353
Shrimp gill net	5382	4318	4234	3613	3389	710	2679
Trat							
Small-scale							
Crab trap	5175	3843	3770	2306	2127	1145	982
Fish gill net	2911	-926	-1018	-1388	-1592	1145	-2737
Shrimp gill net	8607	3985	3673	2333	1669	1145	524
Crab gill net	4157	1880	1742	756	417	1145	-728
Medium-scale							
Push net	26955	18769	18108	17788	16107	1145	14962
Trawl net	56844	40182	38963	38365	35842	1145	34697

[a]US$1 = 20.40 baht (THB).

units of Pang Nga and Nakhon (under 2000 THB/month). On the average, small-scale fishing units had gross earnings of 3500–5300 THB/month depending on location whereas medium-scale units averaged over 30000 THB, with the exception of the 40 push nets in Nakhon, the only medium-scale gear in this location, which averaged just under 8000 THB/month. To the extent that the value of the catch in each location is a reflection of fishery resource availability, the resource was three to five times more abundant or valuable in Chumporn and Trat than in Nakhon and Pang Nga.

Gross family income, obtained by subtracting cash costs from gross revenues, is the maximum income from fishing that the household can consume in the short run. It is not, however, sustainable over the long run because no allowance is made for depreciation of fishing assets. Only one gear group, fish gill net in Trat, had a negative gross family income. There were, however, several small-scale gear groups in Pang Nga and a few in other provinces that earned gross incomes that would not have allowed a bare subsistence without supplementary nonfishing sources of income (Table 6). The same could be said of the trawlers in Chumporn (a medium-scale gear), which earned the lowest gross income among all medium-scale gear groups and locations.

Net family income is obtained by subtracting depreciation from gross family income. It can, therefore, be consumed in its entirety without impairing the household's ability to continue fishing operations in the future. Net family income consists of returns to factors of production owned by the family, i.e., capital, family labour and management, and rents, such as resource rents and rents of ability. All households had positive net incomes except for those using fish gill net in Trat. However, one medium-scale gear group, trawl nets in Chumporn, and several small-scale gear groups in Pang Nga and Nakhon, especially some of those using stationary or nonpowered gear, had extremely low incomes. Purse seines continued to be the highest income group (Table 6).

Evidently, the Nakhon coastal fishery in general, and its small-scale subsector in particular, with an annual average family net income of about 15 000 THB, should be a high priority area for government welfare and development assistance, particularly because this is also a region lacking in nonfishing alternatives. The small-scale fisheries of the other three locations, with average net fishing incomes of 25 000 THB/year and more nonfishing employment opportunities, are second-priority targets. However, urgent attention should be paid to individual gear groups in these locations, such as fish gill nets in Trat and push nets in Pang Nga, which are not earning even a subsistence from fishing and thus are in dire need of outside assistance.

Another concept of profitability is that of operating (or gross economic) profit, which is defined as the difference between gross revenues and operating (or variable) costs. The importance of this measure of profitability lies in the economic principle that zero operating profits forms the dividing point between operation and close-down in the short run. As long as operating (or variable) costs are covered, the fishing unit concerned could continue operating until either the situation improves or fixed assets can be liquidated. Negative operating profits will cause a halt to fishing operations altogether. Again, some gear groups that had negative or very low net incomes — fish gill net in Trat and push net in Pang Nga — also had negative operating profits. Thus, these two types of small-scale technology were not viable under the prevailing economic and fish-stock conditions in their respective locations. It is remarkable that the same types of gear (push net and fish gill net) in different locations (Trat and Chumporn, respectively) were the third and fourth most profitable types of fishing technology. The two most profitable types of gear were purse seines in Chumporn and trawl net in Trat (Table 6).

Net profits were then calculated by deducting fixed costs from operating profit to determine the long-run profitability of various fishing technologies in different locations. On strictly economic criteria, fishing units not covering their total costs (i.e., having negative net profits) would leave the fishery in the long run, switching to the next best alternative from which, by definition, they could earn more. If, on the other hand, net profits (above the opportunity costs of own inputs) are made, new fishing units would be attracted into the open-access fishery until all pure profits (net profits minus management costs) are competed away.

Medium-scale fishing gear such as purse seines, push nets, and trawls were, in general, many times more profitable than small-scale gear. Medium-scale gears in Chumporn and Trat (where they were mostly found) earned 12 600 and 15 300 THB/month in net profit (i.e., after all cash and imputed fixed and variable costs were deducted), compared with only 2000 and 1000 THB/month earned by small-scale gears in the same locations. However, this rule was not without exceptions. Trawl nets in Chumporn, although a medium-scale gear, suffered greater losses than any other gear because of high operating costs and a small catch of high commercial value. Our results on the trawler in Chumporn support a similar finding by Panayotou (1980b) based on the 1977 survey of the trawl fishery conducted by the Thai Department of Fisheries (1979): trawlers less than 14 m long experienced losses in 1977. The unusually large profits by trawlers in Trat are derived from the lightly fished waters bordering Kampuchea. Most profitable types of gear were purse seines in Chumporn, making a profit of 67 000 THB/month, followed by trawls and push nets in Trat, 36 000 and 16 000 THB/month. Fish gill net in Chumporn also earned a reasonable profit, slightly over 6000 THB/month (Table 6). In addition to trawl in Chumporn, other unprofitable gears among the 40 gear groups examined were push net in Pang Nga and fish gill net in Trat, and two groups of miscellaneous combined gears (not shown in the table), all of which suffered losses. The rest, among them some medium-scale gears such as push net in Chumporn and Nakhon, had modest profits of 173–3400 THB/month.

By deducting the opportunity cost of management from net profits, we obtained pure profits or resource rents. As shown in Table 6, resource rents were dissipated for crab gill net and trawl in Chumporn, winged set bag in Nakhon, push net in Pang Nga, and fish and crab gill nets in Trat, all of which were operating below their opportunity costs. Substantial resource rents were still earned by four medium-scale types of gear, purse seine and fish gill net in Chumporn and trawl and push net in Trat. Of the small-scale gear, only shrimp gill net in Chumporn and Pang Nga and cast net in Chumporn appear to be earning resource rents significantly above zero; the rest are just covering the opportunity costs of labour and capital employed, which means that they probably could have earned just as much in their next best alternative employment. It is also remarkable that the small-scale fishery of Trat as a whole is earning negative resource rents (Table 5) whereas the medium-scale fishery operating from the same coast earns enormous resource rents (higher than in any other location studied). The reason lies in the fact that the rich fishery resources of neighbouring Kampuchea are not accessible to the small-scale gears whereas they are to trawlers and other medium-scale gear groups.

Considering the substantial resource rents earned by purse seines in Chumporn and trawlers in Trat, one would expect rapid entry into these two fishery–technology combinations. Although the most recent figures on the number of purse seines throughout the country and trawlers in Kampuchean waters do show an upward trend, the increase is not as steep as would be expected when the enormous profits earned by these two gear groups are considered. The reason lies, presumably, in the special skills and management requirements for purse seine operations and the high risk of operating in Kampuchean waters. Thus the pure profits earned by the two gear groups may not be entirely resource rents. Part of the purse seine profits might be rents of ability and part of the Trat trawl profits, risk premiums.

Factor Returns and Shares

The labour share in net revenues (gross revenues minus material costs and fees and charges) ranged between 13% for trawl in Trat and 114% for push net in Pang Nga (Table 7). This striking disparity is explained by the fact that profits, which are normally part of the share of capital, were negative for the Pang Nga push net and very high for the Trat trawl.

In general, however, labour's share, which includes family labour, tended to be higher among small-scale types of gear such as crab gill net in Chumporn (58%), lift net in Nakhon (38%), nonpowered units in Pang Nga (36%), and crab gill net (43%) and crab trap (39%) in Trat. It was only 13% for trawl nets and push net in Trat and 27% for purse seine in Chumporn both of which were medium-scale and very profitable gears. The tendency, however, for most types of gear was for a labour share in the range of 25–35%. Moreover, the labour share tended to vary inversely with profitability. Gear groups that incurred losses paid a higher percentage of their "net" earnings to labour than those making high profits.

In terms of return to hired labour, purse seines in Chumporn paid the highest wage rate, 274 THB/man-day, partly in terms of a fixed wage rate and partly in terms of share, followed by fish gill net, 97 THB, trawl, 73 THB, and push net, 50 THB, in the same province. In other locations, only push net in Trat paid a comparable wage rate, 64 THB/man-day. For all other types of gear, the return to labour was below the minimum wage rate of 35 THB/man-day (8-hour), being lowest for lift net in Nakhon and crab trap and fish gill net in Trat (Table 7). It should be noted, however, that these returns do not include the value of food and payment in kind, e.g., fish for home consumption.

The return to capital, that is, profit as a percentage of capital cost, was highest in the case of nonpowered gear because of the very low capital cost involved. For the same reason, the return to capital was higher among small-scale fishing units in Chumporn than among purse seines, the most profitable gear in the province. In fact, the concept of return to capital makes little sense for small-scale fishing units.

Among the medium-scale gears, trawl in Trat earned the highest return to capital, 580%, followed by push net in the same province, 227%, fish gill net in Chumporn, 191%, and purse seine in the same province, 108%. Push net earned a similar return, about 35%, in Nakhon and Chumporn. Thus all medium-scale gears with the notable exception of the Chumporn trawl earned a sufficiently high return to more than cover the opportunity cost of capital, that is, the return from investments of comparable risk outside the fishery: the secure interest rate did not exceed 12% in 1978.

Explaining Variations in Profitability

The exceptionally high return to capital for trawls and push net in Trat should be expected because of the high risk of venturing into Kampuchean waters. The high return for fish gill net and purse seines in Chumporn is a reflection of the fishing skill and entrepreneurial ability of their operators as well as of the abundance of pelagic resources in the Chumporn area. Thus, this return consists partly of

Table 7. Returns to and shares of labour and capital by selected types of technology in four coastal provinces, Thailand, 1978.

Type of gear	Return to capital (%) Profit: initial cost	Profit: current value	Return (THB/man-day)[a] to — Hired labour	Family labour	Management	Share (%) Labour	Capital
Chumporn							
Small-scale							
Cast net	243	244	0.0	37.0	94	26.7	73.3
Shrimp gill net	290	339	0.0	30.0	116	20.7	79.3
Crab gill net	18	30	31.5	43.5	9	58.1	41.9
Medium-scale							
Fish gill net	143	191	97.0	122.0	159	37.3	62.7
Push net	33	34	50.0	37.0	107	31.8	68.2
Purse seine	109	108	274.0	198.0	2815	27.0	73.0
Trawl net	-26	-24	73.0	43.0	-96	54.8	45.2
Nakhon							
Small-scale							
Lift net	146	142	6.2[b]	25.3	57	38.3	61.7
Winged set bag	15	16	0.0	11.5	7	31.8	68.2
Shrimp gill net	106	123	29.3	39.8	197	33.0	67.0
Trawl net	57	59	29.4	8.6	41	25.1	74.9
Medium-scale							
Push net	35	36	24.2	24.0	51	31.1	68.9
Pang Nga							
Small-scale							
Nonpowered	1400	1550	0.0	68.3	108	35.7	64.3
Push net	-59	-72	0.0	22.9	15	114.0	-14.0
Winged set bag	224	297	0.0	30.9	136	23.5	76.5
Crab gill net	142	174	0.0	47.0	204	24.1	75.9
Shrimp gill net	377	385	27.3	63.7	303	20.8	79.2
Trat							
Small-scale							
Crab trap	308	358	3.1[b]	41.8	113	39.2	60.8
Fish gill net	-204	-210	6.1[b]	17.1	-103	25.0	75.0
Shrimp gill net	62	127	0.0	54.8	57	34.2	65.8
Crab gill net	35	36	0.0	47.5	24	43.3	56.7
Medium-scale							
Push net	263	227	52.8	30.3	734	13.9	86.1
Trawl net	359	580	73.5	72.1	972	13.3	86.7

[a]US$1 = 20.40 baht (THB); 1 man-day is defined as an 8-hour day.
[b]These values seem unreasonably low but are as reported by the fishermen.

rents of ability and quasi-rents and partly of resource rents. That this is the case is also reflected in the higher wages paid by these two types of gear in Chumporn. From the society's point of view, it appears that there is considerable room for expanding the pelagic fishery of Chumporn and its contribution to employment and fish production.

The reasons behind the large profits of purse seine and fish gill net in Chumporn lie in their catching capacity rather than in any ability to operate at relatively low cost or to obtain a relatively high price. The average purse seine in Chumporn caught 207.5 kg of fish, worth 784 THB, per hour of fishing compared to only 30 kg, worth 68 THB, by the trawl in the same province. The difference in value is only partly due to the fact that the trawl obtained a lower unit price because of the large proportion (65%) of trash fish in its catch. The purse seine had profits of 400 THB/hour and the trawl had losses of 9 THB/hour despite the fact that the operation of the purse seine cost 4.5 times as much per hour as the operation of the trawl.

In contrast, the high profitability of the push net and trawl in Trat is due more to the relatively high price that they were able to obtain for their catch than to either a large catch or a low cost of operation. The average push net in Trat caught only 4.1 kg/hour, much less than the push net in the other three locations, and sold it at the unit price of 36.5 THB/kg compared with unit prices of only 10.1 and 6.1 THB/kg obtained by the same type of gear in Chumporn and Nakhon, respectively. The higher unit price in Trat was due to the better composition of catch in that province; a larger percentage of shrimps of a larger size. This, in turn, was due to the proximity of Trat to the underfished Kampuchean waters. The same reasoning applies to the trawls in Trat, which caught only 12.5 kg/hour, less than half the catch of the Chumporn trawl, but obtained a price seven times higher, and as a result had huge profits instead of losses although their costs of operation per hour were the same as the trawls in Chumporn.

Small-scale fishing units, except for winged set bags in Pang Nga, caught between 0.5 and 5.5 kg of fish/hour but obtained a relatively high price. Shrimp gill net, the most profitable small-scale fishing gear, obtained its highest catch in Pang Nga, 2.5 kg/hour, and its highest price in Trat, 119.5 THB/kg of fish.

Thus, the most important determinant of profits appears to be the interaction between technology and fishing ground. The same technology is not equally profitable in all fishing grounds nor is the same ground profitable for all technologies. Having the right type of gear at the right fishing ground with appropriate skill and entrepreneurial spirit appears to be the recipe for high profits. These three components were present in the three most successful types of fishing gear, purse seine in Chumporn and push net and trawl net in Trat. The question, however, is how a small-scale fisherman with a relatively large debt and few funds of his own can take advantage of changing economic conditions by acquiring a purse-seine if he lives in Chumporn or a trawl or push net if he happens to live in Trat.

Even if the funds were available, there is also the need for training in the new equipment and right attitude toward risk, because, in open-access fisheries, "profitability" is a temporary situation; flexibility is also necessary. Trawlers were very profitable everywhere in the Gulf of Thailand until overentry and overfishing turned them from assets into liabilities.

In the worst possible situation are small-scale fishermen living in areas such as Nakhon because of the paucity of funds, of fish resources, and of nonfishing alternatives. Here, not only credit and training are necessary, but eventual relocation of the surplus fishermen is inevitable, unless imaginative government projects such as coastal aquaculture development provide viable alternatives to coastal fishing.

Some Policy Implications

The first policy implication to be drawn from these findings is that fishing effort should be directed away from the demersal resources of the Gulf of Thailand, which appear to be overfished — at least in the economic sense of negative resource rents. Operators of demersal fishing gear, such as trawls in Chumporn and Nakhon, should be encouraged and assisted to convert their fishing assets to pelagic gear such as purse seines. Despite the greater management requirements of purse seines, their exceptional profitability should suffice to attract the required skills from the large and increasingly unprofitable trawl fishery.

A second policy implication is that there is still room for the trawl fishery in the proximity of the underfished waters of neighbouring countries, such as Trat near Kampuchean waters, but because of the risk factor and political complications as a result of the declaration of exclusive economic zones appropriate arrangements by the government would be necessary.

Another conclusion is that the small-scale fishery is barely earning a subsistence level of income; resource rents have been virtually dissipated and many small-scale fishermen earn no more, and often less, than their opportunity cost, which is no higher than the income of the subsistence farmer in the northeast or the earnings of the unskilled and often unemployed labourer in Bangkok or the provincial capital. Only those small-scale fishermen who can still go after high-value species, such as shrimp and squid, with shrimp gill nets and cast nets still earn something more than a wage for their labour. Of course, helping all small-scale fishermen switch to shrimp gill nets or cast nets would be self-defeating. Even without government assistance, profits are likely to attract enough fishermen into shrimping to dissipate rents in a short while.

It is thus apparent that only restriction of entry into the coastal fishery and development of alternative or supplementary sources of employment and income can improve the income levels of small-scale fishermen. In the absence of government action, their earnings will further decline not so much as a result of increasing fuel costs but as a result of uncontrolled entry from a limitless pool of unemployed labour elsewhere in the country and continued encroachment of coastal fishing grounds by semi-idle trawlers.

Appendix: Terminology and Formulas

A fishing unit is classified as *small-scale* if the current value of its fishing assets (boat plus engine) is less than 20000 THB. Fishing units with more than 20000 THB in assets are classified as *medium-scale*. No large-scale units (over 100000 THB) were surveyed.

A fishing unit is classified as *single gear* if it uses only one type of gear and as *combined gear* if it uses more than one type of gear. Gear types with less than three fishing units were grouped into *miscellaneous single gear* or *miscellaneous combined gear*.

Depreciation of asset equals initial cost of the asset less salvage value divided by economic life, where salvage value equals 10% of initial value.

Opportunity cost of capital equals 15% of total capital investment, i.e., current value of boat and engine.

Cost of debt is actual interest payments on debt reported by the fisherman.

Opportunity cost of family labour was as determined by the fishermen when asked how much they, and other members of their family, could earn from the next best occupation.

Opportunity cost of family inputs equals the opportunity cost of own capital plus opportunity cost of family labour.

Cash costs equals the sum of hired labour cost, material cost, debt, maintenance cost, and fees and charges.

Total costs equals fixed plus variable costs or equals cash costs plus depreciation cost plus opportunity cost of family inputs.

Gross family income equals cash flow or equals gross revenues less cash costs.

Net family income equals accounting profit or equals gross family income less depreciation of capital assets.

Operating or gross economic profit equals gross revenues less operating costs or equals gross family income less opportunity cost of family labour plus interest on debt.

Net economic profit equals gross revenues less total costs or equals operating profits less fixed costs.

Annual values equal monthly values times the number of fishing months.

Return to capital equals the sum of annual net profit and opportunity cost of capital divided by initial value of fishing assets or equals the sum of annual net profit and opportunity cost of capital divided by current value of fishing assets.

Return to hired labour equals the monthly hired labour costs (including salary and share of value of catch) divided by the number of man-days worked per fishing month.

Return to family labour equals the monthly opportunity cost of family labour (including food) divided by the number of man-days worked per month by the operator and family.

Return to management equals the net profits divided by the number of man-days worked by the fishing-unit operator.

Labour share equals the total labour costs divided by the gross revenues less material costs (fuel, nets, and others) and maintenance costs, and fees and charges.

Capital share equals the sum of operating profit plus maintenance costs divided by gross revenues less material costs and fees and charges.

Cost Structure and Profitability of Small-Scale Fisheries in Peninsular Malaysia

L.J. Fredericks, Sulochana Nair, and Jahara Yahaya

This paper analyzes the costs of and returns to fishing operations and the distribution of returns among the productive factors involved in fish production in Peninsular Malaysia.

The analysis is based on costs and production data collected from a random stratified sample of 281 fishing households operating the major fishing gears in the West Coast and East Coast of Peninsular Malaysia. In the initial stage of the survey, undertaken in 1979, the sample fishing households were inventoried to generate socio-demographic data and information on fishing assets. Costs and earnings associated with fishing operations were then studied on a weekly basis for 2 months, generating data on hours spent at sea, number of crew involved, costs, and composition, weight, and value of catch. (For more details on survey methodology and sample descriptions, see Fredericks et al., this volume, p. 46.)

The purpose of this paper is to analyze the cost structure, factor shares, and profitability of small-scale fishing operations by location and gear type, and to derive the policy implications of the findings.

Cost Structure

The costs of fishing operations may be divided into capital costs, incorporating all expenditure on assets, and operating costs for the operation and maintenance of the fishing enterprise.

Table 1 shows the major capital costs incurred in fishing operations. The major component was the engine, which accounted for 59% (East Coast) and 39% (West Coast) of total capital costs for nearly all gear types. Generally, a direct correlation between engine horsepower and engine cost was observed. The second important component of capital costs was the cost of hulls, which varied with boat tonnage. Net and gear costs were aggregated because certain fisheries do not use nets, e.g., shellfishing, handlines, and longline: only for the shrimp trawl nets and drift nets was this a significant part of the total capital outlay. The mean total investment was highest for the East Coast trawl net fishermen and lowest for the West Coast shellfishing operators.

The operating costs of a fishing unit can be broadly divided into running costs — maintenance and repair costs — and crew costs. Running costs consist of outlays on fuel, lubricants, ice, and food for the crew at sea (Table 2). The main component was fuel cost, which was related to the number of days at sea and gear type used. Thus, marked variations in fuel costs were noted, particularly for trawlers as compared to shellfishermen. Cost of food at sea was next in importance, depending on the number of crew members and the owner's generosity. Ice costs were highest for the long-line and handline boats because of the longer fishing trips undertaken. Expenditure on engine oil or lubricants reflected the quality of maintenance undertaken by fishermen. As a percentage of total running costs, this was highest at Port Weld where the proportion of owner-operated boats was highest.

Maintenance involves regular and preventive care to reduce deterioration of capital equipment (engine, gear, and hull) and extend its economic life. These two cost items are grouped together because, in practice, it is difficult to separate them. Generally, expenditure on engine maintenance and repair was the most important item except for trawlers where net repairs and maintenance were sizeable (Table 3). Outlays on hulls were only significant for the shrimp trawlers and shellfishermen of Port Weld.

For all gear types, the captain's wage exceeded the payment to crew members except

Table 1. Distribution of capital costs of fishing assets by gear type and location, Peninsular Malaysia, 1979.

Location and gear type	Hull: Average tonnage	Hull: Capital cost (MYR)[a]	Hull: % of total	Engine: Engine horse-power	Engine: Capital cost (MYR)	Engine: % of total	Gear: Capital cost (MYR)	Gear: % of total	Total capital cost (MYR)
Kuala Trengganu									
Trawl net	14	8510	39	36.0	13100	59	530	2	22140
Handline	12	6620	42	32.8	9060	58	70	<1	15750
Port Weld									
Shrimp trawl net	2	710	22	8.0	1070	32	1510	46	3290
Drift net	5	1340	24	15.2	2330	41	2010	35	5680
Shellfish collection	2	660	42	6.9	900	58	na[b]	-	1560
Pantai Remis									
Shrimp trawl net	5	1420	32	23.6	1500	34	1510	34	4430
Drift net	4	1260	35	15.3	800	22	1530	43	3590
Shellfish collection	2	970	62	6.5	560	36	40	2	1570
Longline	7	2120	49	15.5	2200	51	na	-	4320

[a]US$1 = 2.19 ringgit (MYR).
[b]na = not available.

Table 2. Average running costs per month (MYR)[a] by gear type and location, Peninsular Malaysia, 1979.

Location and gear type	Total running costs: Fuel	Oil	Ice	Food	Total	Days at sea	Running costs per day at sea: Fuel	Oil	Ice	Food	Total
Kuala Trengganu											
Trawl net	564.73	36.27	21.26	88.37	710.63	21.36	26.44	1.70	0.99	4.14	33.27
Handline	305.07	20.76	137.38	102.03	565.24	16.79	18.17	1.24	8.18	6.08	33.67
Port Weld											
Shrimp trawl net	73.74	13.42	8.22	47.68	143.06	19.54	3.77	0.69	0.42	2.44	7.32
Drift net	92.80	12.77	35.25	57.75	198.57	16.33	5.68	0.78	2.15	3.54	12.15
Shellfish collection	63.94	13.22	0.00	47.25	124.41	22.75	2.81	0.58	0.00	2.08	5.47
Pantai Remis											
Shrimp trawl net	177.27	6.31	14.78	54.56	252.92	16.55	10.71	0.38	0.89	3.30	15.28
Drift net	114.07	6.28	14.78	54.56	189.69	16.93	6.74	0.37	0.87	3.22	11.20
Shellfish collection	74.75	7.50	0.00	45.59	127.84	18.77	3.98	0.40	0.00	2.43	6.81
Longline	170.14	6.80	25.36	74.45	276.75	17.50	9.72	0.39	1.45	4.25	15.81

[a]US$1 = 2.19 ringgit (MYR).

in the case of shellfishing operators in Pantai Remis and trawl nets in Kuala Trengganu (Table 4). The highest and lowest average crew costs per fishing day were incurred by the shellfishing operators in Pantai Remis and Port Weld, respectively.

On the East Coast, the running costs of the various gears exceeded crew costs whereas on the West Coast, crew costs exceeded running costs for all gears (Table 3). Repair and maintenance costs accounted for 4% of the operating costs on the East Coast and 9% on the West Coast. Several reasons may account for these regional differences in operating costs. The wage rates are usually higher on the West Coast than on the East Coast where labour surpluses tend to reduce wage rates. Although the average crew size was higher on the East Coast, this was not reflected in higher crew costs because of the lower wage rates. The higher running costs in the East Coast are generally attributable to the larger vessel, engine, and crew size.

The net earnings from fishing enterprises are computed by deducting operating expenses from total receipts from fish sales. These net earnings are distributed between the "net cash crew shares," i.e., the wages or return to labour, and net earnings of the boat share, that is, profits and returns to capital. Where the boat-owner was also the captain, he was entitled to wages, returns to capital, and profits (including a return to management). The total receipts from fish sales are dependent on the price at the landing point, the volume and composition of the catch, and the place and time of landing.

The remuneration for crew was divided among its members, the number of shares for each determined by his status in the boat. Key crew members obtained more shares as a reward for extra responsibility or skill: they received

Table 3. *Cost structure by gear type and location, Peninsular Malaysia, 1979.*

Location and gear type	Running cost Mean (MYR)[a]	Running cost % of operating cost	Repairs and maintenance Mean (MYR)	Repairs and maintenance % of operating cost	Crew cost Mean (MYR)	Crew cost % of operating cost	Total operating cost (MYR)	Depreciation cost (MYR)	Total cost (MYR)
Kuala Trengganu									
Trawl net	711	52	63	5	595	43	1369	144	1513
Handline	565	60	22	2	362	38	949	113	1062
Port Weld									
Shrimp trawl net	143	18	64	8	573	74	780	14	794
Drift net	199	26	61	8	499	66	759	34	793
Shellfish collection	124	24	56	11	345	65	525	11	536
Pantai Remis									
Shrimp trawl net	253	22	121	11	756	67	1130	25	1155
Drift net	190	21	63	7	656	72	909	17	926
Shellfish collection	128	8	19	1	1480	91	1627	10	1637
Longline	277	20	195	14	901	66	1373	57	1430

[a]US$1 = 2.19 ringgit (MYR).

1.25, 1.5, or 2 shares as compared with a single share for an ordinary member (see Elliston 1978:11, for a similar finding). The *taikong* or captain normally received more shares as he played a key role in the fishing operation. Where his share was the same as for other crew, he was paid 15–20% of the boat-owners' share as an incentive (see Yahaya 1976:40, for a similar finding). In certain cases, this commission was shared with other "deserving" crew members.

Catch and Earnings

The catch varies with the gear technology used. These variations depend on the nature of the gear itself and how it is used: trawls are unselective in harvesting fish (see Elliston 1978:9) and the hook-and-line fisheries only catch fish attracted to the bait in a particular locality. The condition of the fishing grounds also determines the gear that can be used. Thus, hook-and-line is used in areas unsuitable for trawlers, for example, in rocky and irregular sea beds. The quality of fish caught by different gear types also varies: handlines tend to produce high quality fish whereas, in the longline fisheries, quality depends on the period for which the line is immersed.

Indeed, the volume of catch for the various gears and locations varied considerably (Table 5). The largest catch was obtained by trawl net operators in Kuala Trengganu (1709 kg/month), the lowest by the shrimp trawl net operators in Port Weld (75 kg) and the shellfish operators in Pantai Remis (89 kg). On the East Coast, catch appears to be related to the number of days spent at sea. However, on the West Coast, although catch increased with vessel size, no positive relationship between catch and days at sea was noted. The average catch per crew member on the East Coast was 2.2 times that on the West Coast, with the lowest catch being recorded in Port Weld. However, the regional difference in terms of catch value was narrower because the average price per kilogram was higher on the West Coast than on the East Coast. The price differences may be due to quality differences because the West Coast fishermen caught mainly prawns, which had a higher unit price.

Among gears, the highest volume of catch per crew member was produced by the trawl net operators of Kuala Trengganu whereas the highest value of catch per crew member was obtained by shrimp trawl net operators in Pantai Remis. The highest average value of catch per fishing day was obtained by the Kuala Trengganu handline operators on the East Coast and the lowest by the Port Weld shellfish collectors on the West Coast (Table 5).

The "net" earnings by fishing gear were obtained by deducting running costs from the total value of the catch. (For a concise analysis of the relationships among the factors affecting the profitability of a fishing boat, see Elliston 1978:11–12.) The highest net earnings were obtained by the trawl net fisheries in Kuala Trengganu on the East Coast and the lowest by the shellfisheries in Port Weld on the West Coast (Table 6). The net earnings of all comparable gear types in Pantai Remis were 2.3 times those in Port Weld. The net earnings per fishing unit ranged from 400 to 1200 MYR/month, or from 18 to 65 MYR/fishing day (2.19 ringgit

Table 4. Average crew costs by gear type and location, Peninsular Malaysia, 1979.

Location and gear type	Payment to captain: Wages (MYR)[a]	Kind (MYR)	Bonus (MYR)	Total (MYR)	% of total	Payment to crew: Wages (MYR)	Kind (MYR)	Bonus (MYR)	Total (MYR)	% of total	Total (MYR)	Average crew costs per day at sea (MYR): Total	Per man
Kuala Trengganu													
Trawl net	174	32	56	262	44	270	63	<1	333	56	595	28	7.3
Handline	156	11	30	197	54	149	16	<1	165	46	362	22	5.7
Port Weld													
Shrimp trawl net	320	19	9	348	61	208	5	12	225	39	573	29	14.7
Drift net	322	34	0	356	72	135	3	0	138	28	494	30	13.2
Shellfish collection	343	0	0	343	99	2	0	0	2	1	345	15	12.6
Pantai Remis													
Shrimp trawl net	446	28	0	474	63	261	20	0	281	37	755	46	24.0
Drift net	444	32	0	476	73	163	17	0	180	27	656	39	22.8
Shellfish collection	606	1	0	607	41	872	1	0	873	59	1480	79	52.6
Longline	442	33	0	475	53	394	32	0	426	47	901	51	22.4

[a]US$1 = 2.19 ringgit (MYR).

Table 5. Volume and value of catch per month and per fishing day by gear type and location, Peninsular Malaysia, 1979.

Location and gear type	Total catch Volume (kg)	Total catch Value (MYR)[a]	Average crew size (number)	Average catch per person Volume (kg)	Average catch per person Value (MYR)	Average catch per day Volume (kg)	Average catch per day Value (MYR)
Kuala Trengganu							
Trawl net	1708.90	1905.19	3.8	449.71	501.37	80.00	89.19
Handline	158.57	1549.82	3.8	41.73	407.85	9.44	92.31
Port Weld							
Shrimp trawl net	74.54	597.10	2.0	37.27	298.55	3.81	30.56
Drift net	129.11	654.17	2.3	56.13	284.42	7.91	40.06
Shellfish collection	183.86	524.22	1.2	153.22	436.85	8.08	23.04
Pantai Remis							
Shrimp trawl net	221.59	1315.95	1.9	116.63	692.61	13.39	79.51
Drift net	251.72	1142.37	1.7	148.07	671.98	14.87	67.48
Shellfish collection	89.20	760.56	1.5	59.47	507.04	4.75	40.52
Longline	196.30	1413.09	2.3	85.35	614.39	11.22	80.75

[a]US$1 = 2.19 riggit (MYR).

[MYR] = US$1). The higher net earnings obtained by the East Coast Malay boat owners compared to the Port Weld Chinese fishing operators contrast with the usual pattern where the East Coast Malay rural households generally earn less than the West Coast Chinese households.

By deducting crew costs and repair and maintenance costs from "net" earnings, we obtain the operating profit to the boat owner. Crew costs include the wages, payments in kind, and bonuses to both captain and labourers, as reported in Table 4. Operating profit is an important concept because it determines whether the fishing unit will continue operating (positive operating profit) or cease operations (negative operating profit). The operating profit was negative for all gear types in Port Weld and for shellfish collection in Pantai Remis (Table 6). The most profitable types of gear were trawl nets and handlines operating in Kuala Trengganu on the East Coast.

Positive operating profit indicates only short-run viability, however. Long-term viability requires positive net profit, which is defined as operating profit minus depreciation and opportunity cost of capital. Depreciation cost is a way of charging the original investment or capital expenditure against revenue over the economic life of the investment. The usual problems arise in estimating the portion of the capital investment consumed in a given time period: they are further complicated by the lack of standardization in the boats and equipment.[1] In calculating depreciation costs, the straight-line method of calculating depreciation[2] was used and the salvage value of the hull and the engine assumed to be zero as no formal second-hand market exists for boat hulls and engines. Again, the highest net profits were generated by the East

[1]A study by the U.S. Peace Corps (1970:60–61) points out that to judge the economic life of an asset, reference may be made to standardized objects. For instance, trawlers may refer to anything between a 5-ton boat powered by a 6-horsepower (HP) engine to a 60-ton boat powered by a 200-HP engine. There are also wide variations in the use of materials, design, construction, and frequency and quality of maintenance of boats with similar tonnage as well as wide variations in fishing conditions. A second obstacle is the lack of a firm basis for calculation because the same boats will depreciate in efficiency at different rates under different fishing methods. Because most of the engines used in trawlers are second-hand, reconditioned truck engines, it is difficult to estimate actual age of these engines and their expected economic life. Again, to estimate a residual or salvage value for a fishing boat at the end of its economic life is difficult because discarded boats may be used as fish carriers, for instance, or they may not even have scrap value — many old boat hulls are left to rot and sink at their moorings.

[2]According to the straight-line method, depreciation equals the difference between the purchase price and the salvage value of an asset divided by its economic life. The purchase value of the asset was obtained from the survey and the economic life was obtained from knowledgeable people associated with the fishing industry: it was estimated to be 15 years for the boat hull and 10 years for the boat engine. Elliston (1978:4) reports that the expected life of a boat can be 6–20 years, and that of an engine (125 HP) is 8–12 years.

Table 6. Average monthly earnings, costs, and profits (MYR/fishing boat)[a] from fishing by gear type and location, Peninsular Malaysia, 1979.

Location and gear type	Gross revenues	Running costs	Net earnings	Costs: Crew	Costs: Maintenance	Operating profit (gross income)	Depreciation costs	Opportunity cost of capital	Net profit	Opportunity cost of management	Resource rents	Average return to crew
Kuala Trengganu												
Trawl net	1905	711	1194	595	63	536	144	138	254	200	54	156
Handline	1550	565	985	362	22	601	113	98	390	200	190	96
Port Weld												
Shrimp trawl net	597	143	454	573	64	-183	14	21	-218	300	- 518	287
Drift net	654	199	455	499	61	-105	34	36	-175	300	- 475	216
Shellfish collection	524	124	400	345	56	- 1	11	10	- 22	300	- 322	287
Pantai Remis												
Shrimp trawl net	1316	253	1063	756	121	186	25	31	130	300	- 170	397
Drift net	1142	190	952	656	63	233	17	22	194	300	- 106	386
Shellfish collection	761	128	633	1480	19	-866	10	10	-886	300	-1186	987
Longline	1413	277	1136	901	195	40	57	27	- 44	300	- 344	392

[a]US$1 = 2.19 ringgit (MYR).

Coast trawl net and handline operators. With the exception of shrimp trawl nets and drift nets in Pantai Remis, all West Coast gear types had negative net profits on the average, and therefore were not viable in the long run — unless the sampling period was not representative or favourable changes were expected in the future. It is worth noting that longlines were the only gear type that was viable in the short run but not in the long term because they just covered variable costs (Table 6).

Finally, by deducting from net profit the opportunity cost of management (assumed to be 200 MYR on the East Coast and 300 MYR on the West Coast), we obtain pure profit or resource rents, which are indicative of the net value of the resource (if positive) and of the extent of economic overfishing (if negative or zero). Resource rents are negative throughout the West Coast and positive but modest on the East Coast (Table 6). This finding agrees with biological evidence of biological overfishing on the West Coast and underfishing on the East Coast (especially for the demersal fishery). The same finding, however, seems to contradict the income figures given in the socioeconomic study (this volume, p. 46), where it was found that fishing incomes are considerably higher on the West Coast than on the East Coast. However, the income values, unlike profits, include the remuneration to crew; the lower income levels on the East Coast are related to the boat ownership structure in that region and include the share of returns from fishing operations accruing to nonboat-owning crew members (crew size was considerably larger on the East Coast vessels). This is why the income values for the East Coast approximate more closely the average return to crew (Table 6) than they do on the West Coast.

We may thus conclude that returns to labour were higher on the West Coast whereas profits were higher on the East Coast, a pattern that reflects the relative scarcity of labour on the West Coast and of capital on the East Coast. On the West Coast, the opportunity cost of labour is considerably higher and the fishery resources more depleted than on the East Coast where there is surplus labour and unexploited resource potential. Moreover, the average value of capital assets per fishing unit is many times higher and their ownership more concentrated on the East than on the West Coast. Thus low wages on the East Coast reflect the low opportunity cost of human resources, and low profits (negative resource rents) on the West Coast reflect high labour costs and low yield from depleted fish resources.

Summary of Findings and Policy Implications

The major cost components in fishing were found to be the capital cost (incorporating investment in fishing assets) and operating and maintenance costs. On the average, the highest capital investment was shown by the East Coast trawl nets and the lowest by the West Coast shellfish operations. The capital outlay on engines was highest, representing 51% of total asset investment, with hulls and fishing gear representing 38 and 11%.

The operating costs of fishing enterprises were made up of running costs, repair and maintenance costs, and crew costs. Crew costs constituted the largest part of total operating costs of fishing units on the West Coast but, on the East Coast, running costs were more significant. Of the total running costs, fuel was the largest expenditure item for all gear types in the two regions.

Fishing productivity varied widely by location, with the volume of catch per crew member on the East Coast being 2.2 times that on the West Cost reflecting, to some degree, the differences in the two locations in terms of capital investment and resource abundance. However, regional differences in catch value were significant with the average prices on the West Coast being higher than those on the East Coast, reflecting the dominance of prawn resources in the former region.

Profitability differed significantly among gears and locations, with the highest profit accruing to the East Coast trawl nets and the lowest to the Port Weld shellfishing operations. Similar variations were observed in terms of resource rents.

These differences have important implications both in terms of race and location. In the sample, all East Coast fishermen were Malays, whereas those in Port Weld on the West Coast were Chinese. The finding that higher profits and rents were obtained on the East Coast deviates from the general pattern where the earnings of rural non-Malays on the West Coast are higher than those of Malays on the East Coast. Variations in net earnings among gear types in different locations can probably be explained by differences in resource abundance and labour costs.

Locational differences, arising from differences in wage rates, resource availability, etc., seem to have the greatest impact on the distribution of the returns to labour and capital, thus implying that policy measures to improve incomes and productivity of fishing households should attempt to adopt resource conservation measures and influence wage rates rather than attempt to change the ownership structure of fishing assets. However, it is clear that the promotion of boat ownership per se will ensure that shares for the entrepreneur and capitalist will remain with the fisherman boat owner, rather than accrue to nonsea-going investors.

Marketing System

The Marketing System in the Small-Scale Fishery of Sri Lanka: Does the Middleman Exploit the Fisherman?

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In the Sri Lankan fisheries, as in other small-scale fisheries in Asia, fish traders are also money lenders. A middleman, as a fish trader–moneylender is usually called, lends money to a fisherman, usually with no collateral, no explicit interest rate, and no repayment schedule, except for a commitment by the fisherman-debtor to deliver his entire catch to the creditor as long as the debt is outstanding. It is commonly argued that by combining the dual function of money lending and fish marketing, the middleman "exploits" the fisherman in the sense of paying him a price substantially lower than the prevailing market price (see Berube 1968). It is also a commonly held hypothesis that, in traditional fishing communities, a combination of eonomic power and sociocultural and informational forces provide the conditions for either monopsonistic (single buyer) or oligopsonistic (few buyers) control of fishermen by middlemen.

This study investigates the general hypothesis that conditions of monopsony and oligopsony characterize the fish marketing structure of Sri Lanka at the various stages of marketing, and that, as a result, the marketing structure should be held responsible for the low prices received by the fishermen and the high prices paid by the consumers of fish. This hypothesis suggests that middlemen–traders earn excess or abnormal profits and that the system is structured by the ability of middlemen–traders to constrain the entry of potential competitors into the system through high capital or skill requirements, through natural monopoly due to economies of scale, or else through the operation of formal or informal barriers, including threats of violence.

The study tests this hypothesis by evaluating the costs of operation of two different types of middlemen, the assemblers and the retailers, the returns to their capital and management compared to their respective opportunity costs, and the levels of pure profit earned. I also investigate whether a monopsonistic–oligopsonistic situation prevails generally among assemblers while a more competitive system operates among fish retailers.

The study has been restricted in scope by the use of cross-sectional data because time-series data were not available and, thus, the empirical findings are only applicable for the year 1980, which could have been an unusual year. The study does not examine the question of technical efficiency in the marketing system and its effect on fish prices, and the effects on price of possible inefficiencies resulting from poor handling, transport, and storage, limitations of chilling facilities, failure to use commercially possible by-products, etc., fall outside its scope. Economic transactions at the wholesale fish markets and the hinterland (interior) retail markets were also not studied. Similarly, supply of inputs by middlemen was not considered.

Analytical Framework and Survey Methodology

The analysis takes place within the basic economic theory of market structure. In a perfectly competitive marketing system, no factor of production earns more than its opportunity cost and pure profit cannot exist in the long run because it is eliminated through competition. However, even under competition, some profits may remain in the long run in the form of rents of ability or of efficiency, which

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are earned by the most efficient, competitive producers. Under conditions of imperfect competition, which include monopsony, oligopsony, and monopsonistic competition, pure profit is expected to be positive even in a long-run equilibrium. In a disequilibrium situation, when economic conditions have suddenly changed and sufficient time has not elapsed for entry to eliminate excess profit, positive pure profits do not necessarily indicate conditions of monopsony or oligopsony (monopoly or oligopoly).

If middlemen are able to achieve some degree of monopsony or oligopsony in the marketing system, large margins of pure profit — as opposed to rents of efficiency — will be viewed as reflecting lack of competition and barriers to entry. Under such conditions, the differentials between the producer's price and the consumer's price of fish cannot be explained wholly in terms of the opportunity costs of the services provided by the middlemen. The reduction or elimination of pure (monopsony or oligopsony) profits will result in an increase in the price paid by the middlemen to the fishermen or a decrease in the price received by the trader from the ultimate consumer, or both.

Apart from macrolevel data on price trends of different varieties of fish obtained from the Ministry of Fisheries, all other data were collected from primary sources by field researchers of the Marga Institute. Fish assemblers operating in 20 fish-landing centres (marine, lagoon, and inland) and fish retailers who carry on their operations in the same 20 fishing centres as well as in three retail fish markets were selected for study. These purposively selected sites were representative of the various types of resource base and of fishing technology and various religious–ethnic groups, geographical regions, and marketing patterns.

Fish assemblers were stratified into five subcategories and fish retailers into 10 subcategories on the basis of critical differences in their fish marketing practices. A 10% random sample was selected from each subcategory. A total of 284 assemblers and retailers were sampled (see Tables 4 and 7 for sample size by individual type of assembler and retailer). In addition to this, a census of retail fish traders was conducted in 19 retail markets in fish-producing areas and 34 retail markets in nonproducing areas. The retail markets selected were not meant to be representative of the whole island. They were purposively selected as markets to which fish produced in the Hambantota District (southeast part of Sri Lanka) finds its way to the consumer through chains of middlemen–traders.

Description of the Fish Marketing System

Fish, being a perishable commodity, has to be disposed of steadily and efficiently to ensure that it reaches the consumer in acceptable condition. A considerable distance — spatial as well as operational — separates the producer from the consumer for whose use the fish is harvested. Thus the coordinated functions of the commercial units that intervene between the producer and the consumer are of crucial importance. The marketing system operates through a set of intermediaries performing useful commercial functions in a chain formation all the way from the producer to the final consumer. The commercial units comprising the fish-marketing system can be grouped into three categories — fish assemblers, fish wholesalers, and fish retailers.

Beach assemblers obtain their supplies of fish directly from the fishermen as they come ashore with their catch. The wholesalers, who operate in small numbers in principal markets and in relatively large numbers in the St John's wholesale fish market in Colombo, usually obtain their supplies from beach assemblers. Fish retailers in turn obtain their supplies either from a market wholesaler or from a beach assembler or, when convenient, directly from the producer at the landing point. The entire marketing function of the fishing industry is conducted through these three categories of middlemen. In this chain of commercial relationships linking fish producers with fish consumers, the private sector handles about 98% of the fish produced in the country and the remaining 2% is handled by the Ceylon Fisheries Corporation (CFC).

Assemblers and the Credit System

Assemblers can be subdivided into five types:

- Type 1 who specialize in small fish and sell equally within the producing district, in the interior of the country, and in Colombo;
- Type 2 who specialize in big fish and sell equally within the producing district, in the interior of the country, and in Colombo;
- Type 3 who send their fish for sale primarily in Colombo;
- Type 4 who assemble export varieties such as prawns and lobsters; and

Table 1. Distribution of boat owners according to capital source in the small-scale fisheries, Sri Lanka, 1980.

Sources of capital	Sample boat owners Number	%
Savings		
Fishing-related	250	37
Other sources	68	10
Fish assembler	115	17
Bank	74	11
Money lender	74	11
Relatives and friends	54	8
Government	27	4
Cooperative society	14	2
All sources	676	100

- Type 5 who take their fish for sale primarily in the interior of the country.

One of the arguments commonly used to support the monopsony–oligopsony model of fish marketing is that fish assemblers perform a critical financing role through which they economically enslave the fishermen. Middlemen are believed to give loans to fishermen who, in turn, are required to sell their entire catch to the assembler who "exploits" them by setting the price for the catch. Although loans are classified as interest-free, a hidden interest is built into the price of fish paid by the assembler to a debtor who receives a lower price than a nondebtor.

Fish assemblers constitute the prime source of finance for fishermen in the Sri Lankan small-scale fishery for less than 20% of boat owners (Table 1). Generally, fishermen have been able to accumulate sufficient savings, with government subsidies, to buy craft and gear and meet their working expenses without much recourse to the assembler. It is possible that the financing role of the fish assembler began to decline in Sri Lanka with the introduction of various credit facilities and easy loan schemes and subsidies by the government and with the increase in fishermen's incomes that accompanied the mechanization of the small-scale fishery.

In all the fishing centres studied, it was observed that assemblers buy fish at the same price from those suppliers who have borrowed money from them as from those who have not. However, they differentiate between their debtor and nondebtor suppliers by periodically giving assistance in the form of gifts and other services to nondebtors. Such payments are made through nonformalized channels and are classified, in the present paper, as "welfare" expenses of assemblers. Only 13% of the sample assemblers made no welfare payments to fishermen, whereas 37% paid up to 5000 LKR and 50% over 5000 LKR in such expenses (15.63 rupees [LKR] =US$1).

Assemblers' sources of fish supply

The catch of fishing craft is disposed of, after the owner and crew members take small quantities for home consumption, in various ways (Table 2) but the most popular mode is by auction at which assemblers and retailers bid. However, although 64% of all fish produced is sold by auction, fish assemblers purchase only 23% of their stocks in this way (Table 3). This implies that it is the retailers more than the fish assemblers who buy fish at the auctions conducted on the beach. Of the different types of fish assemblers, the auction is the dominant mode of purchase for those who sell fish in the interior of the country. Equally, the auction dominates the sale of small, low-priced, varieties of fish but not that of the large, higher-priced, varieties (Table 2). About 60% of the supplies of assemblers of export varieties and of assemblers who send their fish to Colombo are obtained at previously negotiated prices from assured suppliers (Table 3): these two types of assemblers assure themselves of regular supplies.

Table 2. Disposal of catch (%) by type of craft in the small-scale fisheries, Sri Lanka, 1980.

Type of craft	Sample size	Sold: By auction	Sold: At previously negotiated price	Consigned by producer to a distant market	Given as payment to bait suppliers	Sent for processing
Modern						
3.5-tonner	130	50	23	25	0	2
17.5-footer	60	77	4	12	0	7
Traditional						
Mechanized	100	75	5	5	0	15
Nonmechanized	245	43	38	4	2	13
Beach seine	100	79	3	5	4	9
All types	635	64	16	10	1	9

In contrast, the assembler selling in the interior of the country buys 75% of his stocks at the fish auctions (Table 3). He opts for a noncontractual supply because the demand for fish in the interior of the country is relatively price elastic. The demand in the Colombo market — especially for the large, higher-priced, fish varieties — is, by comparison, less price elastic in the short run because here the consumers come from the higher income groups of the urban sector. The demand for the export varieties (prawns and lobsters) is also relatively inelastic in the short run because the demand comes from export firms that have contracted to supply a foreign consumer market.

In addition, 27% of the supplies of assemblers comes from craft owned by the assemblers themselves. This reflects the desire of fish assemblers to be assured of a minimum regular supply. It also shows the tendency for the assemblers' savings to be invested in fishing craft and gear because fish production is one of the few activities that a fish assembler could successfully manage within the context of a normal work schedule. Here too the exception is the fish assembler who sells in the interior who does not invest in craft and gear because the success of this type of trading activity requires a very flexible supply source that can be matched to the highly elastic demand of the interior market.

However, although the methods employed by fish assemblers to purchase their stocks of fish may vary from centre to centre, the two dominant modes of purchase are clearly the fish auctions on the beach and contractual arrangements.

On the western coastal belt, the purchase of stocks of fish by beach assemblers is done at fish auctions, which form a regular feature at these fishing centres, when hauls of fish are brought ashore. In contrast to the western coastal belt where many of the fishermen are Roman Catholic, fishing centres on the southern (Buddhist) and eastern (Muslim) coasts are known to have favoured the system of selling to assemblers at prices negotiated earlier. Until the process of fishery modernization, started in 1958, began to generate positive and far-reaching results in the fishery sector, indebtedness to assemblers is said to have been characteristic of the southern and eastern fishing villages. As discussed earlier, the system of indebtedness to fish assemblers has broken down substantially (see Table 1). Concomitant to this process is the progressive increase of fish auctions on the southern coast.

Where assemblers buy fish at negotiated prices, the producer may have a debt or dependency relationship with the assembler or the assembler tries to negotiate such longer-term arrangements with suppliers selected on the basis of certain other criteria (Table 4). Ties of kinship or neighbourhood do not appear to be important criteria for assemblers in selecting their suppliers except in the case of assemblers of export varieties (prawns and lobsters), 57% of whom buy from suppliers on a kinship–neighbourhood basis. They, together with assemblers selling to Colombo, buy fish on the basis of regularity of supply on the part of suppliers with whom they form long-term contractual relationships. Assemblers who supply the Colombo market also place importance in selecting suppliers who have a reputation of being highly skilled fishermen. This criterion for selecting long-term contractual suppliers is not so important for the other types of assembler.

Besides the private commercial sector of beach assemblers, CFC also engages in obtaining stocks of fish through its island-wide organisation of 53 purchasing centres spread over 13 fish-producing districts. (Each district

Table 3. Assemblers' sources of fish supply (%), Sri Lanka, 1980.

Assembler specialty	Sample size	At previously negotiated price: From borrowers	At previously negotiated price: From nonborrowers	From craft owned by by assembler	From fish auction	From other sources
Small fish	22	13	13	40	13	21
Large fish	24	16	24	35	19	6
Selling in Colombo	10	30	20	30	10	10
Export varieties	22	39	22	26	4	9
Selling in interior	12	25	0	0	75	0
All assemblers	90	25	17	27	23	8

Table 4. Distribution (%) of assembler-producer relationships by type of assembler, Sri Lanka, 1980.

Relationship	Assembler specialty: Small fish (22)[a]	Large fish (24)	Selling in Columbo (10)	Export varieties (22)	Selling in interior (12)	All assemblers (90)
Financial obligations						
Yes	40	27	63	89	33	50
No	60	73	37	11	67	50
Close friend or relative						
Yes	18	33	29	57	0	27
No	82	67	71	43	100	73
Skill (brings bigger catches)						
Yes	0	20	57	29	0	21
No	100	80	43	71	100	79
Reliability of supply						
Yes	50	29	64	56	0	40
No	50	71	36	44	100	60

[a]Values in parentheses are sample sizes.

has a district manager and each purchasing centre, a purchasing officer.) Like the assemblers in the private sector, CFC until recently gave loans to fishermen to secure fish supplies. In 1979, a meagre 2822 t of fish were obtained through these purchase schemes. Fish obtained through these CFC purchasing schemes is dispatched to the terminal in Mutwal and to CFC's wholesale market in Keselwatta, Colombo, either in vans belonging to CFC or in hired vans.

Indicators of the degree of competition among assemblers

The degree of monopsony–oligopsony in the fish-marketing system is a function of the barriers to entry into the marketing sector. There could be economic barriers arising out of capital requirements and natural monopoly due to economies of scale, as well as management barriers derived from specialized skill requirements and physical barriers sanctioned by local power structures. (A local power structure consists of an arrangement of local interest groups, social classes, economic and political groupings, and persons having different and often conflicting degrees of access to production, financial, and political resources, and also having different kinds of linkages with economic, social, and political groupings, organizations, and persons outside the local scene.)

The number of fish assemblers–wholesalers operating in each of the different fishing villages studied (Table 5) indicates that physical barriers to entry seem not to exist in a manner detrimental to the interests of fishermen and there are substantial numbers (25–75) of assemblers operating at most of the sample fishing centres. Physical barriers do not exist at Mirissa and Pitipana but, in other centres, assemblers from outside the fishing village are not permitted to buy fish even at a fish auction. The customary barrier in these centres is enforced, if necessary, by physical violence. However, anyone from within the fishing village itself is permitted to enter the fish-assembling trade. The numbers of assemblers, strictly confined to persons from within the village in all but two centres, are so large that price-fixing on the part of the assemblers as a group is not practically feasible; unless, of course, the bulk of fish-assembling activity is in the hands of only four or five traders (price leaders) at each centre with all the other assemblers (price followers) together handling just a fraction of the turnover in the total fish production. It is theoretically possible that the economic barriers mentioned earlier are effectively minimizing the equitable sharing of

Table 5. Numbers of fish assemblers-wholesalers and retail fish traders at sample fishing centres, Sri Lanka, 1980.

Fishing centre	Wholesalers	Retailers
Udappuwa	32	95
Kudawella	42	75
Mirissa	25	125
Barudelpola	8	26
Nagarkovil	3	50
Uswetakeiyawa	15	20
Mattakotuwella	75	60
Mullaitivu	25	40
Puttalam	25	25
Thoduwawa	44	125
Myliddy	3	65
Pitipana	6	50

fish-assembling activity at any one centre. A scrutiny of the distribution of gross incomes, net incomes, and capital value of fishery assets of fish assemblers (Table 6) will indicate the degree to which economic barriers constrain the equitable sharing of fish-assembler activity among the participants.

Income as well as capital assets are distributed quite evenly among assemblers (Table 6). It could, therefore, be surmised that economic barriers do not, by and large, operate to hinder a fairly equitable sharing of fish-assembling activity among participant middlemen-traders. The distribution of economic assets and incomes among assemblers suggests the functioning of a competitive system of fish trading in the assembling sector rather than of a monopsonistic–oligopsonistic one.

The data that have been presented so far enable us to gauge the validity of the charge of price collusion that is often made against the fish assemblers (for example, Kirby and Szezepanik 1957 and Berube 1968).

The fish assembler's goal is not the maximization of the price differential between the price paid to the fisherman and the price received from the buyer, it is the maximization of total profits, rather than profits per unit of turnover as reflected by the price differential. Because maximization of total profits is the assembler's goal, price collusion becomes less feasible, because total profits are a function not only of price differential but also of total turnover. The higher the price the assembler is ready to pay to his/her suppliers, the greater would be the amount of fish received. An assembler could increase turnover by raising the price that he/she pays to the fisherman. It would pay an assembler to narrow the margin of profit per unit handled as long as the percentage increase in the volume of supplies exceeds the percentage decrease in the margin of profit per unit handled — as long as the margin continues to be positive.

Table 6. Distribution (%) of fish assemblers[a] by income levels, Sri Lanka, 1980.

Financial class (000 LKR)[b]	Gross income	Net income	Capital assets
<25	0	5	33
25–50	0	0	25
50–100	4	2	13
100–200	28	28	18
200–500		36	
500–1000	17	29	11
1000–5000	33	0	
>5000	18	0	0

[a]Sample size was 90 assemblers.
[b]US$1 = 15.63 rupees (LKR).

This has important implications for fish assembling. Fish assemblers, as a group, would benefit from price-fixing as long as a price agreement is supported by all participant assemblers. In practical terms, such price-fixing has a chance of success only if the number of assemblers is small and can be kept so by high barriers to entry. When the numbers involved are large and the barriers to entry are low, as in the case of Sri Lanka, price collusion will invariably fail.

In all but the more isolated and inaccessible fishing villages — which, in any case, are very few in Sri Lanka — price collusion cannot be effective. Competition among assemblers is reinforced by fishermen's access to market information, on the basis of which they can agitate for a fair price. As a result of the development of social and physical infrastructure in Sri Lanka during the last three decades, not only have the levels of education in the fishing communities improved remarkably but also the levels of physical and social access to market information have improved.

The present-day small-scale fisherman of Sri Lanka is well informed of prevailing and changing market conditions. He/she gets information about prices in different retail and wholesale market centres through bus conductors and drivers of vans, trucks, and buses who commute between fish-landing and fish-consuming centres. If the fisherman sees some type of contradiction or antagonism growing between an assembler and one of his employees, the fisherman exploits the situation to "tap" the employee for relevant market information. Today's small-scale fisherman is a rather sophisticated type of producer who keeps in touch with the market through informal channels of communication.

Retailers

The consumer obtains her/his requirements for fish from the fish retailer who, in turn, obtains supplies either from the producer or from the wholesaler or fish assembler (see Table 7 for types of retailers). The economics of the fish-retailing sector, therefore, would have a direct bearing on the prevailing consumer price of fish. Given the price at which the retailer obtains supplies, the consumer price of fish will be a function of the technical and economic efficiency in the fish-retailing sector. Technical inefficiencies could result from waste and spoilage, which in turn are related to factors such as the available postharvest technology, including ice and chilling facilities. Economic inefficiencies would result from pure monopoly profits, which are associated with monopsonistic or monopolistic conditions, or both, in the retail market, or from failure to use all marketing inputs at their optimum level.

Retailers of fish operate as bicyclists, *pingo* carriers, box carriers, slab owners, ground retailers, and motorcyclists, and as salesmen who travel in vans. They can be distinguished in two categories: those who use their own means of transport and those who utilize only their labour and management skills. Two different categories can also be discerned according to the source from which they obtain stocks of fish: those who buy their supplies directly from the producers and those who buy their supplies indirectly, from beach assemblers or wholesalers.

Pingo and box carriers buy 44–88 kg of fish each time for retail sales, bicyclists procure 66–132 kg of fish, and motorcyclists and van salesmen as much as 220–1100 kg for each round of retail sale.

Such retail sale of fish takes place in the areas around fishing centres, in urban areas in proximity to wholesale fish markets, and in areas in the hinterland. There are other retailers who do not move about but use slabs or planks or baskets on which they display their fish and attract customers. *Pingo* carriers, box carriers, and bicyclists take their fish to the homes of consumers whereas motorcyclists and van salesmen transport their stocks to places in the hinterland and operate generally from a fixed, central, location.

The CFC engages in retail trade but its impact is only minimal in this sector. It has 14 retail outlets in Colombo, but it only operates one itself: two have been leased to the Ceynor Foundation and 11 to the local private sector. In addition, 13 CFC agents in the suburbs of Colombo obtain supplies of packeted frozen fish from CFC at a discount. There are also 16 CFC retail outlets in the districts. Six trucks belonging to CFC were also doing a certain amount of itinerant fish retailing in Colombo (Fernando and Abeydeera 1980). With this level of operation, CFC can, at present, be expected to have only a minimal impact on the retail sector of the fish marketing system in Sri Lanka.

Of all retailers, 49% are in the 26–45 year old age group and 48% were above 46 years of age: the balance, 3%, are in the 16–25 year old age group. In contrast, there was a significantly lower proportion (13%) of assemblers in the "senior" age group. The reason for this is that older persons find it difficult to cope with the stresses of fish assembling.

Recent years have seen the emergence of a new type of modern fish retailer — the motorcycle retailer — who seems to enter the fish retailing sector with little experience in fish production (100% of motorcycle retailers sampled had less than 3 years of experience as fishermen, whereas only 16% of all retailers sampled have less than 3 years experience as fishermen). In contrast, the traditional fish retailers seem to have entered the sector after being engaged in the fish-producing sector for a substantially longer period. The bicycle retailer category has persons with varying periods of experience as fishermen, and 86% of *pingo* retailers have as much as 30–40 years fishing experience. *Pingo* retailers are usually persons who have retired from the fish-producing sector because they are no longer able to brave the seas and some may have had accidents or injuries while working as fishermen. Apart from *pingo* retailers who have perhaps retired as fishermen owing to age or injury, all other types of fish retailers are former fishermen who have moved away from the production sector to the retail trade sector to better their prospects and earn higher incomes. These persons usually have opted to invest their fishery savings in retail fish trading. They reflect the process of social mobility operating in the small-scale fishery.

Retailers' sources of fish supply

Because the study was confined to the fish retail traders of the fish-landing districts, the data show that retailers usually obtain their supplies of fish directly from the producers by going to the beach and bidding at fish auctions, or by negotiating a price, or by purchasing from fish assemblers. The fish-purchase profile could be different if the fish retail sectors of nonfish-landing districts were studied.

Except for the bicycle, ground, and slab retailers, all other types of retailers obtain over 50% of their supplies at fish auctions on the beach. The slab retailer, who operates at a central market, obtains most of his supplies from assemblers because it is inconvenient for a slab retailer to leave the market and come down to a fishing centre to purchase his daily requirements of fish. Ground retailers buy supplies from crewmen, retired fishermen who have obtained gifts of fish from producer-kinsmen, craft owners (who may sell a part of what they would otherwise take home for consumption),

Table 7. Distribution (%) of fish retailer–producer relationship by type of retailer, Sri Lanka, 1980.

	Retailers										
Relationship	Small fish (68)[a]	Large fish (4)	Van (12)	Motor-cycle (6)	Bi-cycle (54)	*Pingo* (10)	Ground (10)	Slab (10)	Box (10)	District (10)	All (194)
Financial obligations											
Yes	25	0	80	0	0	0	20	0	0	20	15
No	75	100	20	100	100	100	80	100	100	80	85
Close friend or relative											
Yes	25	0	33	0	30	0	0	0	50	34	21
No	75	100	67	100	70	100	100	100	50	66	79
Skill (brings bigger catches)											
Yes	0	0	34	0	15	0	0	0	0	0	5
No	100	100	66	100	85	100	100	100	100	100	95
Reliability of supply											
Yes	25	0	30	0	17	0	0	0	80	0	15
No	75	100	70	100	83	100	100	100	20	100	85

[a]Values in parentheses are sample sizes.

and labourers who have been paid in fish. There appears to be a strong tendency for bicycle retailers to invest their savings in small fishing craft (traditional craft, traditional craft with outboard motor, 17.5-foot fibreglass boat with outboard motor, etc.) from which they are, in turn, assured of a regular supply of fish. Retailers also perform a financing role — although in a very small way — by lending money to producers.

Although 11% of retailers do not spend money for assistance to regular suppliers (welfare expenses) in times of need, 78% spend annually up to 2000 LKR each on "welfare." Except in the case of the box retailer for whom the kinship–neighbourhood–friendship criterion seems relevant and the van retailer who seems to lend money to some of his/her suppliers, no longer-term relationships appear to exist between individual retailers and producers (Table 7).

Indicators of competition among retailers

Formally organized fish retail markets exist in a large number of urban service centres scattered throughout the country. These formalized markets are owned by local government authorities who issue licences to fish traders. To obtain a licence from such an authority to sell fish on a slab in any of these markets usually requires money as well as influence. Entry into fish retail markets run by local government authorities, in other words access to a market slab, is limited by the number of licences issued: 26% of retail markets sampled in fish-producing districts had less than five slab holders, 53% had six to nine, and 21% had 10–12. For the retail fish markets sampled in nonproducing districts, 94% of such markets had less than five slab-holders and the rest had from six to nine. The practice is for persons who obtain access to slabs in these fish retail markets to entrench themselves as fish retailers in such markets for long periods by ensuring — usually through the use of money and influence — that their licences are renewed every year. The number of licences that are issued being few, access to slabs in formalized fish retail markets is thereby limited to a very small number of retailers.

If all fish retailing in the country were confined to the formal fish retail markets, which in turn have restricted to small numbers the slab holders who have rights to sell fish in such retail markets, a monopsonistic or oligopsonistic market structure would ensue. In reality, however, the situation is quite different. In any geographical area, in addition to the market slab retailers, various other types of fish retailers (e.g., bicycle, box, van, motorcycle, ground retailers, etc.) operate competitively with one another as well as competitively with the market slab retailers of the area. In the coastal districts, retailers of various types come to the fish-trading centres and make their purchases, often directly from the producers and sometimes from assemblers. The numbers of retailers who come on a regular basis to the sample fishing villages are shown in Table 7.

Although the total number of fish retailers operating competitively in the fish-producing districts is substantially large, the theoretical possibility of a few retailers controlling the bulk of the retail trade in fish with the others participating only to a small degree must be investigated before we can conclude that the socioeconomic climate for the existence of monopsony–oligopsony does not exist in the retail fish-trade sector of the coastal districts. The distribution of gross income, net income, and capital assets of fish retailers (Table 8) indicates the level of economic participation by different fish retailers.

There is considerable spread of gross and net incomes among fish retailers, but the somewhat skewed distribution of assets is explained by the fact that the 8% whose assets are worth more than 20 000 LKR are van owners. Thus, there is little indication of monopsonistic–oligopsonistic tendencies in the retail fish-marketing sector.

On the contrary, the different subdivisions of the retail fish-marketing sector — slab, ground, box, bicycle, motorcycle, and van retailers — compete with each other to attract customers. The consumer's choice regarding the source from which to buy her/his requirements of fish will be guided by three criteria — price, quality, and convenience. Fish retailers also compete with each other on these criteria. Given the large number of fish retailers operating in competition with each other in any given coastal area, oligopsonistic practices such as price collusion cannot prevail in the fish retail sector of the fish-producing districts of Sri Lanka.

Table 8. Frequency distribution (%) of fish retailers[a] by income levels and value of assets, Sri Lanka, 1980.

Financial class (000 LKR)[b]	Income: Gross	Income: Net	Capital assets
<10	0	35	90
10–20	4	36	2
20–40	15	9	5
40–75	30	5	3
75–100	19	9	0
100–500	21	6	0
>500	11	0	0

[a]Sample size was 194 retailers.
[b]US$1 = 15.63 rupees (LKR).

Profitability of Assembling and Retailing

Several indicators are used to provide estimates of profitability of fish assemblers (Table 9) and retailers (Table 10). Gross income consists of total revenues less cash costs. This concept is important for an understanding of trading operations. The trader can continue consuming gross income as long as fixed assets last. After that, however, because no allowance has been made for depreciation, no funds remain to replace the capital assets. Thus, gross income is sustainable only in the short run, not in the long run.

Net income consists of gross income less depreciation cost. Net income is sustainable because provision has been made for the replacement of capital items. Thus, in the long run, the trader can continue consuming net income and save nothing from it. It consists of the return to capital and family labour (including management).

Gross economic profit (or operating profit) consists of total revenue less variable costs. Traders will continue operating in the short run as long as gross profits are positive or at least zero. As long as the enterprise covers its variable costs, it will go on operating because it cannot dispose of the fixed assets in the short run.

Net economic profit consists of gross economic profit less fixed costs: that is, total

Table 9. Annual incomes, profits, and returns to capital and management by type of fish assembler, Sri Lanka, 1980.

Assembler specialty	Income (000 LKR)[a] Gross	Income (000 LKR)[a] Net	Economic profit (000 LKR) Gross	Economic profit (000 LKR) Net	Opportunity cost of management (000 LKR)	Pure profit[b] (000 LKR)	Fixed capital (000 LKR)	Return to capital (%)	Return to management (LKR/day)
Small fish	94	85	96	69	36	33	70	73	378
Large fish	103	84	102	49	36	13	147	32	272
Selling in Colombo	191	148	199	96	36	60	327	51	795
Export varieties	673	628	346	219	48	171	345	88	2121
Selling in interior	151	136	149	111	36	75	111	122	443

[a]US$1 = 15.63 rupees (LKR).
[b]"Pure profit" (equivalent to net profit less opportunity cost of management) may consist of monopoly, rents, resource rents, or rents of ability.

Table 10. Annual incomes, profits, and returns to capital and management by type of fish retailer, Sri Lanka, 1980.

Type of fish retailer	Income (000 LKR)[a]		Economic profit (000 LKR)		Opportunity cost of management (000 LKR)	Pure profit (000 LKR)	Fixed capital (000 LKR)	Return capital (%)	Return to management (LKR/day)
	Gross	Net	Gross	Net					
Small fish	6.6	6.3	6.7	6.0	4.9	1.1	2.2	73	37
Large fish	5.6	5.3	5.9	5.1	4.6	0.5	2.5	43	31
Van	92.4	87.6	90.9	75.7	36.0	39.7	36.9	136	290
Motorcycle	53.8	52.3	55.1	50.1	7.5	42.6	12.1	381	268
Bicycle	8.1	8.0	8.1	7.9	3.8	4.1	0.7	634	49
Pingo	5.6	5.6	5.7	5.5	3.3	2.2	0.3	737	34
Ground	8.6	8.6	8.7	8.4	4.5	3.9	0.6	659	56
Market slab	16.2	16.1	10.3	9.9	9.1	0.8	0.9	132	33
Box	4.5	4.4	4.6	4.3	3.2	1.1	0.4	325	29
District	9.4	9.4	8.5	8.2	6.4	1.8	0.6	378	45

[a]US$1 = 15.63 rupees (LKR).
[b]"Pure profit" (equivalent to net profit less opportunity cost of management) may consist of monopoly rents, resource rents, or rents of ability.

revenue less total cost. If net economic profit is positive, trading operations will be sustainable in the long run because the enterprise can continue in the long run only if it covers its total costs. Thus, net economic profit is an indication of the long-run viability of a business. "Pure profit" is net profit minus the opportunity cost of management. The latter is taken to be earnings that would accrue to a trader if he/she were to hire out his services as a manager in a similar business venture. The opportunity cost of management is measured here by the average remuneration of hired managers in similar trading activities and, as such, it does not include rents of ability and/or a premium for risk. Pure profit is an important concept as it reflects the degree of competition prevailing in the market. In a perfectly competitive system, pure profit does not exist: it is eliminated through competition. Therefore, under conditions of perfect competition, pure profit can only be a short-run phenomenon. Pure profit can be negative in situations where certain factors of production are not earning their opportunity costs but are constrained to stay on for sociopolitical reasons.

Return to capital is calculated by expressing the sum of pure profit, opportunity cost of own capital, and interest on borrowed capital as a percentage of the current value of capital assets. Return to management is calculated by dividing net profit by the number of man-days (8 hours) worked by the trader. Pure profit, return to capital, and return to management are three alternative indices of profitability.

Although it has been shown in the earlier parts of this paper that conditions conducive to the existence of monopsonistic-oligopsonistic marketing practices do not exist, by and large, in either the fish-assembling or the fish-retailing sectors, Table 9 and 10 indicate the existence of pure or monopoly profits of fairly substantial magnitude in the various types of fish assembling and retailing. This apparent contradiction is explained by the fact that pure or monopoly profit in these tables includes rents of ability and premium for risk earned by the assemblers and retailers. Obtaining fish supplies from producers and marketing them within a competitive structure calls for personal ability that cannot be reproduced at will and is therefore inelastic in supply. These abilities, therefore, earn a rent. Fish assemblers and retailers earn substantial rents of ability within a marketing structure that is, by and large, competitive (Tables 9 and 10). The rents differ in magnitude according to the relative scarcity of the abilities required for the different modes of fish assembling and retailing.

Summary and Conclusions

This paper was directed toward the identification and evaluation of the degrees of monopsony-oligopsony present in the fish-assembling and fish-retailing sectors of the fish-marketing system in Sri Lanka. Monopoly-monopsony and perfect competition are the two theoretical extremes of capitalism, but neither of the two theoretical extremes exist under empirical conditions. All empirical market forms fall somewhere between the two extremes, some being guided more by conditions of monopoly and others by conditions prevailing under perfect competition.

This paper endeavoured to identify the degree of imperfection in the markets of fish assembling and fish retailing in Sri Lanka and its effect on fishermen's earnings.

Having identified the socioeconomic processes and tendencies that inhibit the continuance of monopsonistic–oligopsonistic practices in the fish-marketing system, the magnitudes of "pure" or monopoly profit (inclusive of rents of ability) accruing to the various types of fish assemblers and retailers have been calculated.

As seen in the earlier sections of this paper, there are no physical constraints operating against the entry of capital into the fish retailing sector in the fish-producing districts. Capital from the fish-producing centre itself is free to enter the fish-assembling sector in all fishing villages. There are, also, some centres (such as Mirissa) where capital from outside the fishing village is allowed entry into the fish-assembling sector. Although the requirements of capital for all but two types of fish retailing (van and motorcycle) are relatively small, the average capital investment in fish assembling is substantial, ranging from 69 263 to 344 500 LKR. Difficulty of access to capital may be one reason for the continuance of pure or monopoly profits in fish assembling and rent of ability and premium for risk are the others.

Differences in the percentage returns to capital among the various types of fish-assembling activities were also apparent. For instance, although assemblers taking fish to the interior enjoy a 122% return to capital, those sending fish to Colombo, whose capital assets are in fact three times larger, earn only a 51% return to their capital. It is economically natural, therefore, for assemblers who send fish to Colombo to switch over to taking fish to the interior. It is possible to suggest, as a hypothesis, that such a mobility of capital within the fish-assembling sector is taking place and that the pure profit found by this study is a short-run phenomenon: this hypothesis would have to be tested through a time-series analysis. For the retailers, it is evident that, with the exception of the van and motorcycle retailers, the high returns to capital are due to the very low level of capital invested by most types of retailers. In terms of absolute levels of net economic profit, all retailers, again except van and motorcycle retailers, enjoyed very modest profit margins.

Until fairly recently, most of the varieties of large fish produced in different parts of the country were transported to Colombo, which was then the centre dominating the consumer market for fish. The smaller varieties, which fetched lower prices, were sold by bicycle, *pingo*, ground, and market slab retailers within a short distance of the producing centres, and to a lesser extent to the outskirts of the producing district by assemblers of small fish who disposed of them to market slab retailers and sometimes directly to consumers in the outlying areas of the fish-producing district. Box retailers, too, played a role in distributing fish in the bordering parts of the fish-producing districts by taking their boxes of fish on public transport to these areas and selling either to market slab retailers or directly to consumers. The other major urban centres in the country also received supplies of fish from the Colombo wholesale market and to a marginal degree directly from fish-producing centres. In other parts of the interior, hardly any fresh fish was received and inhabitants were resigned to consuming dry fish, which is mostly imported.

In the meantime, socioeconomic changes that had been taking place in the country for some time began to open up new possibilities for enterprising fish assemblers and particular types of fish retailers who were looking for lucrative trading opportunities. For one thing, the development projects that had been started by successive governments in the interior parts of the island, relatively distant from the fish-producing coast, began gradually to bear fruit, first by increasing income (and consumption) levels and next by generating a dispersed pattern of urban growth in what had been relatively undeveloped parts of the island. At about the same time, due to the difficulties of obtaining foreign exchange, imports of dry fish were severely curbed, reducing the availability of fish to the people who lived in the interior.

This was the backdrop against which the more enterprising coastal fish assemblers and retailers began to explore and open up the interior consumer markets for their trade. From the mid-1970s, one saw the growth of a new type of fish assembler — the assembler who sells fish in the interior — and also of a new type of retailer — the retailer who takes fish by van and retails it in the interior. Since about 1978, yet another type of retailer has emerged — the retailer who uses a motorcycle to transport fish much further into the interior than was possible with an ordinary bicycle. These new types of fish traders, displaying new types of abilities, emerged and grew in response to the falling levels of rents of ability they had enjoyed previously by selling in the fish-producing districts or by consigning their stocks to the Colombo wholesale fish market. They moved into new types of fish-trading enterprise with the idea of earning higher rents of ability and perhaps temporary monopoly rents.

The 1970s also saw the opening up of export markets for prawns and lobsters and the rise of the assemblers of export varieties. Such assemblers, however, could emerge only in those centres that had access to prawn or lobster resources. They established linkages with the fish-export firms in Colombo — that is, with the modern trading sector. They displayed a new type of ability unfamiliar to the traditional forms of fish assembling. In the short run, they earned the highest level of rents of ability enjoyed by any assemblers. It is possible that seeing the high level of pure profit, more and more capital and enterprise will move into these more recent types of fish-assembling and fish-retailing activities, and that, with time, the rents of ability enjoyed by those particular types of assembler and retailer will fall. For the present, there have been no time-series analyses that could support or disprove this contention. All we have are the impressions of persons who are generally well informed about the fisheries sector who say that assembling for and retailing in the developing interior parts of the country are types of fish-marketing activity that are rapidly gaining ground.

We may then conclude that the fish-assembling and fish-retailing markets appear to be fairly competitive despite high rents of ability and, possibly, disequilibrium profits earned by various types of assemblers and retailers. Policy should be aimed at eliminating these rents, either through state intervention in restructuring marketing arrangements in such a way that less commonly available skills and abilities will no longer be required for making a successful fish assembler or retailer, or through a program of identifying and diffusing the required skills and abilities for successful fish-marketing activities.

The fish transport system, which was developed during the era of low-cost fossil fuels, still continues to operate although fuel prices have risen dramatically during the last decade. Fish distribution to consumption centres has been by truck and van rather than by train. Trucks and vans that take fish to the consumption centres return to the production centres with a load of ice. Now that the government is following a policy of decentralizing ice production and having ice plants close to production centres, fish trucks and vans would have to return empty to the production centres because the pollution of these vehicles in transporting fish does not permit them to be used to transport any other goods. This leads to a waste of capacity and consequently high transport cost for fish. Policy can be directed toward developing a truck or van that can be pollution-free after transporting fish so that it can be used for other goods on the return journey to the production centre.

The state can further take steps to provide market information on a daily basis from the main consumption centres in the island to the production centres. Such information would help increase the bargaining power of the fisherman vis-à-vis the trader.

Marketing System for Fish in the Philippines

Aida R. Librero

Under the Philippines' Expanded Fisheries Development Program for 1978–87, the target minimum growth rate for fish production has been set at 5.5% per year, with projected sectoral growth rates of 10.8, 4.5, and 5.5% for the inland (aquaculture), municipal, and commercial fisheries. Production, however, is only half the task. An effective system of fish distribution from the point of production to the point of consumption should complement the production thrust if increased production is to benefit the consumers. Moreover, fish marketing should be efficient to allow it to expand as fish production increases.

A critical analysis of the fish-marketing system in the country is, therefore, in order. This paper attempts to do this through a review of pertinent studies and surveys on the subject. Limitations of this paper are imposed by the very nature of the literature available, which tend to be area-specific (limited to a particular landing area and market or province) and sectorally stratified as either inland (aquaculture), municipal, or commercial fisheries alone.

Market Structure

Market structure may be analyzed in terms of the degree of concentration of sellers and buyers (see appendix for a list of the various types of sellers and buyers of fish in the Philippines); product differentiation; and conditions of entry and exit. Several studies have shown that, for all sectors in Philippine fisheries, market structure can be classified as oligopolistic (see, for instance, Guerrero and Darrah 1975; Navera 1976; Navera and Librero 1976; BFAR and BAEcon 1977; De la Cruz and Lizarondo 1978; Lizarondo et al. 1979; Piansay et al. 1979).

The common practice among producers, especially the commercial fishing-boat operators and fish-pond operators, is to concentrate on the production side of the fishing industry and relegate the marketing to representatives or agents. This creates another participating group in the fish-distribution channel: the brokers.

A broker is ordinarily defined as an agent who specializes in selling or buying for his/her principal without actually having possession of or title to the goods. He receives a commission that is a percentage of the value of the goods sold or a flat rate per unit of goods bought or sold. He may have no power to agree on prices and to bind his principal unless the latter has full knowledge of the facts and consents to such purchase or sale. The broker cannot legally act on his own interest to the detriment of his principal. Such provision usually prevents a broker from representing both buyer and seller in the same transaction.

However, fish brokers in the Navotas Fish Landing and Market Authority (NAFILMA)[1] and the various fish markets of the country were no ordinary brokers. Although they receive commission and represent their principal like the ordinary brokers, they also had possession and physical control of the fish catch consigned to them. They had an unwritten obligation to dispose of or sell all the fish consigned to them at the prevailing prices. Once the broker agreed to sell the fish, it was considered sold at prices prevailing at the time of sale and he had the power to agree on prices. He received payment for the fish sold and paid the producers the proceeds of the sale minus commission.

In some cases, fish brokers were also engaged in production through fish-farming or even commercial fishing. Thus, in addition to fish coming from other fishing-boat operators, they had their own catch at their disposal.

[1]Now the Navotas Fishing Port and Fish Market (NFPFM).

Degree of concentration of sellers and buyers

Approaching an oligopolistic market structure, the number of fish sellers in the fish-marketing setup was very small compared to the number of buyers. In NAFILMA, an average of 31 fishing boats in the area unloaded about 400 t/day that was sold to about 1000 buyers through 24 brokers.

In other locations too, there were smaller number of sellers than buyers (BFAR and BAEcon 1977). In Iloilo, each producer transacted with 75 buyers and each broker served 33 buyers daily. In Bacolod City's wholesale markets, there were only 30 producer-operators and only 10 fish brokers, while in Zemboanga City, each operator served an average of eight buyers each and 10 buyers transacted with each broker daily. A similar situation was found in Quezon Province, where only 67 fish-pond operators from 12 municipalities supplied the bulk of fish-pond products in the province.

There were indications that as the market level goes down from the wholesale to retail levels, the ratio of buyers to sellers increases logarithmically.

Product differentiation

Fish varied as to species, size, and degree of freshness. Some producers were identified as producing particular species of fish and being associated with the source (e.g., fishing grounds) and fishing method used. For example, fish-pen and fish-pond operators produced milkfish or *Tilapia*, fishermen in Palawan waters caught primarily round scad, and truckers from Bicol and Quezon provinces brought in "first-class" species such as *tangigi, pampano,* and *lapu-lapu.*

Physical characteristics such as size and degree of freshness also differentiate the product. Fish catch of commercial fishing boats may not be of equivalent degree of freshness to that unloaded by municipal fishermen. This may be explained by the time element involved, because the former are usually at sea 3–5 days or more whereas the latter's operation involves one night at sea.

Conditions of exit and entry

Producers

Entry into the industry depends upon the manner in which a producer commences operation. For instance, to start as a municipal fisherman would be easier than as commercial fishing-boat or fish-pond operator. For the latter two, the main barrier is the large capital requirement, both for fixed investments and for operations. For a relatively large commercial fishing boat, operators reported a capital investment of 15 million PHP and three others reported 0.5–1.0 million PHP (7.38 pesos [PHP] = US$1). Operating capital ranged from 35 000 to 200 000 PHP/month. However, smaller boats (about 3–5 ton) had a fixed investment of some 50 000 PHP. Moreover, a fisherman has to be licenced and meet all government requirements before he/she can operate a commercial fishing boat.

Furthermore, at important landing places like Navotas, there were only a handful of brokers relative to the number of suppliers. These brokers preferred dealing in large volumes and, therefore, only large-scale producers or suppliers could enter such markets.

Similarly, exit from the market is not easy. The same barriers to entry would also limit the exit. With the considerable investment in fixed assets and high development costs, a fish-pond operator cannot easily shift to other business if, in the process, he/she discovers that the operation is not profitable enough.

Brokers

The main factors limiting entry of brokers into the market are the need for a licence and the high capital requirements, especially in major landing ports like Navotas, where fish in large volumes is usually sold on credit. In this market, brokers needed capital of up to 500 000 PHP to be able to pay the suppliers promptly and fully. They also gave cash advances to maintain goodwill and establish customer loyalties. The brokers' organization in the area sets limit to the number of brokers. Finally, selling of fish on credit could become a barrier to exit. The presence of large amounts of collectibles may prevent a broker from leaving the business readily.

Brokers in Iloilo, Bacolod, and Zamboanga believed that factors such as establishment of goodwill and customer loyalty and, in some cases, capitalization and acquisition of licences, created no barrier to their entry into the market. They claimed that licences and permits were easy to secure at minimal fees. Furthermore, they pointed out that establishing a tie with fish producers was not a problem because such action was largely dependent on the prospective broker's relationship and treaty with the supplier. Because fish brokers are generally commission merchants, capital requirements do not pose as serious a problem as with producers. Some brokers said that their capital consisted

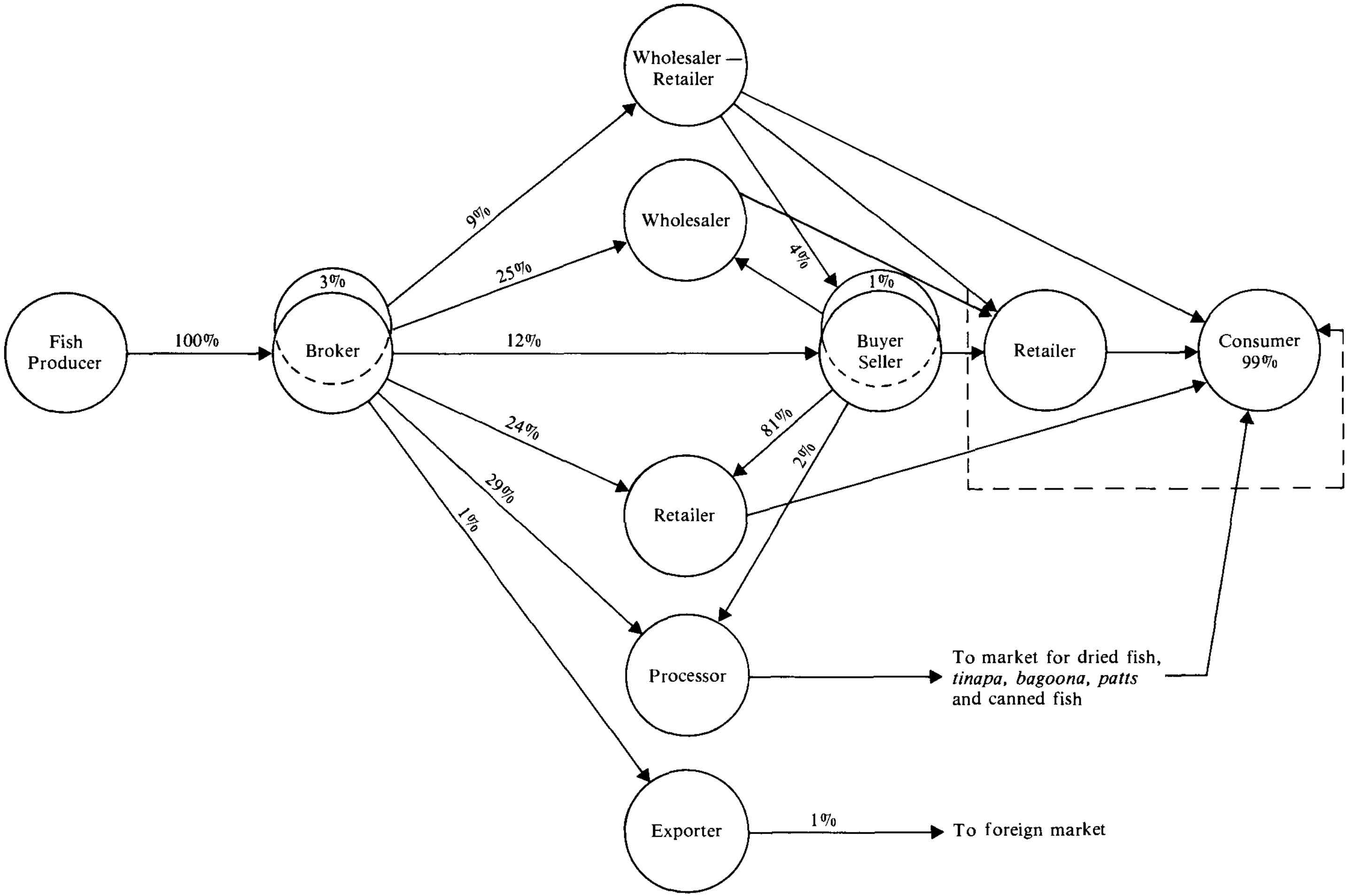

Fig. 1. Fish marketing channels at the Navotas Fish Landing and Market Authority (NAFILMA); portion enclosed in dashed lines takes place outside NAFILMA (from Navera and Librero 1976).

merely of paper and pencil. For operations, they needed enough only to pay rent, salaries, and miscellaneous expenses until sales were negotiated and commission collected. The only barrier was assurance of regular fish supply, but established brokers were given preference by both fish producers and fish buyers.

Buyers

The relative ease or difficulty of entry into the fish market depends greatly on the type of buyer. The capital requirement is higher for a wholesaler than a retailer because the volume and value of transactions involved are relatively higher. For transactions involving credit, one important factor that could limit entry was "customer loyalty, trust, or goodwill."

Marketing channels

Direct marketing between producer and consumer is rare and practiced only by some municipal fishermen. In most cases, producers channel their catch through agents so they can concentrate their energies on production.

At Navotas, all suppliers in the wholesale market[2] channeled their catch to the brokers who in turn sold to the different types of buyers. In other landing areas and markets, however, some suppliers transacted business directly with the buyer. Among Quezon fish-pond operators, 54% disposed of their harvest through brokers. In Iloilo, only 30% of the fish unloaded was handled by brokers. In Zamboanga, an even smaller percentage (15%) was sold through brokers. In the case of municipal fisheries in Camarines Sur, all catch was sold directly to buyers without the intervention of any broker (Pinsay et al. 1979).

Figs. 1 and 2 show the flow diagrams of fish marketing in Navotas and Iloilo. The shortest channel has two stages and no intermediaries, but this was rather rare and found only among municipal fishermen and producers in Iloilo and among fish-pond operators in Visayas and Mindanao.

Market Conduct and Performance

Where the number of sellers is small compared to the number of buyers, the sellers can choose their methods of sale. The most common practices are auction sale, contract sale, and first-come-first-served basis.

[2]Except for two retail market halls used as outlets for municipal fishermen where business was not transacted through brokers and the usual channel was from municipal fisherman (producer) to retailer (buyer) to consumer.

Auction sale

The prevalent practice of sale involving relatively large volumes of fish is through auction where buyers compete by bidding. Bidding may be open or secret with the latter being more widely practiced. Open bidding is done simply by verbally declaring the bids of all the prospective buyers for a particular fish lot (any number of tubs). After all the bids are received, the seller awards the lot to the highest bidder.

Secret bidding is done by a prospective buyer declaring his bid by whispering the price he wants to pay. After receiving some bids, the seller awards the fish lot to the successful buyer. Known as *bulungan* (literally translated as whisper), this form of fish auction is a time-honoured practice employed widely by producers and brokers. At the Navotas wholesale market, *bulungan* is practiced by all brokers.

As a rule, fish lots are awarded to the highest bidder. Such veiled transactions are paradoxically open to many possibilities, however, and the sellers' choice is frequently based on such nonprice considerations as honesty or integrity of the buyer, credit standing, and loyalty (Padua 1979). This is quite understandable because, in Navotas, fish are sold through an honour system: that is, fish are sold on credit to be paid before the next purchase. When fish sales are in cash, the price become the sole deciding factor.

Contract sale

Contract sale is instituted through preagreed terms of sale and payment between the buyer and the seller. This assures the producers of a definite outlet and the buyer of fish a supply.

Contract sale is common among fish-pond operators particularly those far from trading centres who do not want to take the risk of spending a great deal for transport and handling without the benefit of a sure market outlet. Often the buyers themselves pick up the products from the fish ponds during harvest, in which case transport and handling costs are shouldered by the buyers.

Contract buying is practiced by brokers who want a steady supply of fish. To seal the agreement and to establish goodwill, cash advances are usually offered to producers.

Contract sale could also be done not because of previous agreements but because of moral obligation. Thus, preferences in the award of sale are often given to regular customers or *suki* and friends over unfamiliar buyers.

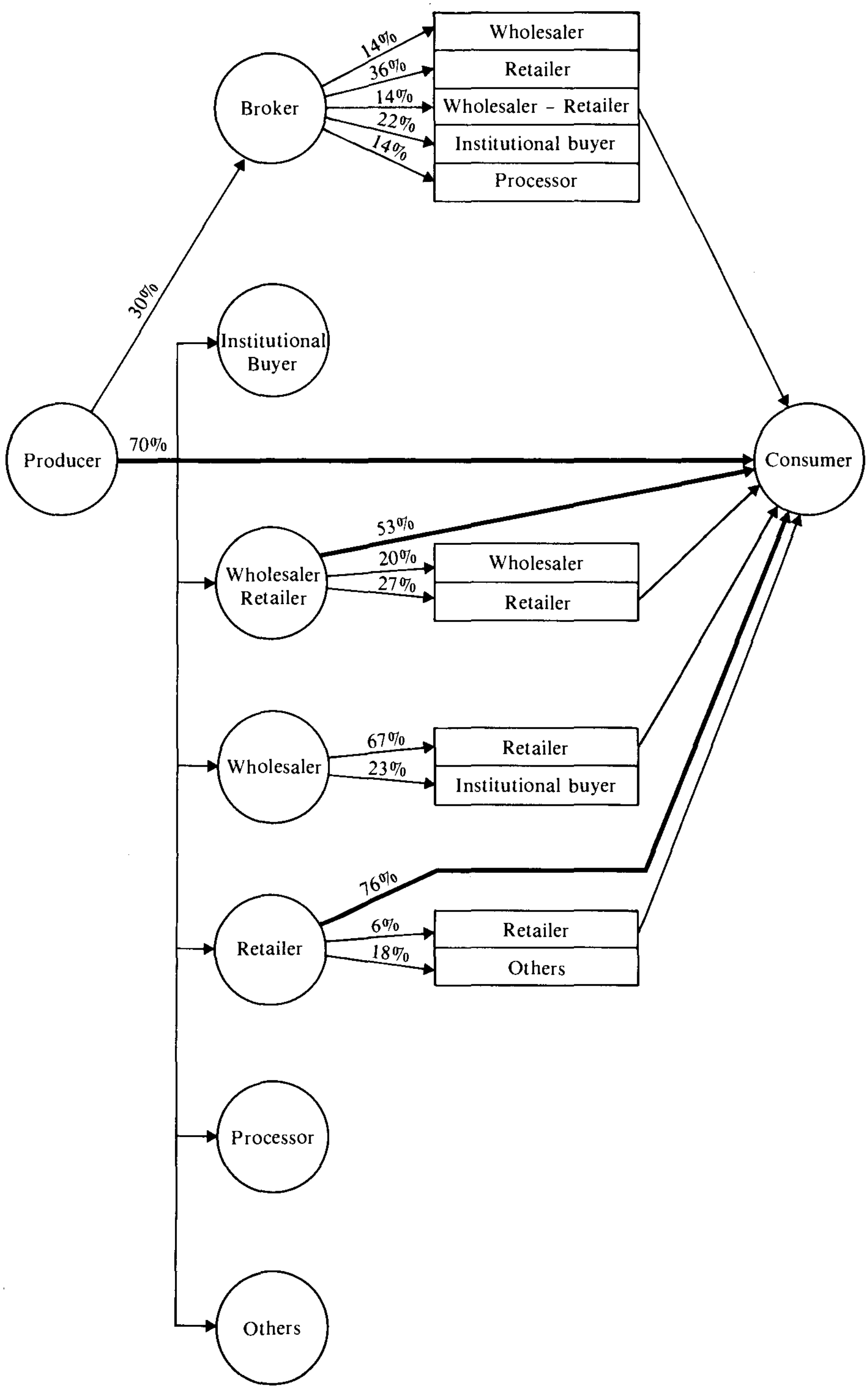

Fig. 2. Channels of distribution of fish marketing, Iloilo City (from BFAR and BAEcon 1977).

First-come-first-served basis

When sellers have established fixed price quotations for their fish lot, sale is awarded to the first buyer who agrees to buy the lot. This manner of sale is particularly true of transactions involving small volumes of fish and of retailers who sell fish on cash basis.

Terms of sale

Between producers and brokers

In general, each fishing boat operator directs his catch to a particular broker regularly. Each party knows to whom (from whom) to distribute (secure) supplies. As producers' representatives, the brokers perform the selling function for which they are paid a commission of 5–7% of the gross sales after the day's transaction. Because fish are usually sold on credit, a broker employs his own capital in paying the suppliers promptly and fully, and at the same time gives such advances as are necessary to maintain goodwill. On the other hand, there were cases when producers extended 1–3 days' credit to their brokers.

Between brokers and buyers

As producer's representatives, brokers are free to negotiate with any buyer. Generally, brokers sell their products on credit payable before the next purchase. In these cases, the creditworthiness of the buyer is the most important factor considered by brokers. Familiarity and close relations with some buyers plays a limited role in the broker's choice of a buyer. In cases where the exchange is on a consignment basis, the buyers usually pay their respective brokers at the end of the day's transactions; and, in some cases, payments are remitted the following day. There are also transactions that involve cash and installment payments.

Among different buyers

Cash-and-carry is the general selling practice reported by buyers. However, credit is also established with regular customers as well as with selected close friends and relatives under exceptional cases.

To make sure that their current revolving capital is used at the optimum level, most middlemen who serve other middlemen demand cash-on-delivery selling arrangements.

Pricing policies

The oligopolistic market structure makes it possible for the sellers (producers and brokers) to have their own pricing policies. Pricing variables usually considered (Navera 1976:85) are credit standing, honesty, bargaining power, the usual and actual quantity of purchases (lot size), the type of buyer, the quantity of fish supply by species and in the aggregate, the fish species, the degree of freshness, and the seller from whom fish was bought. Other factors that are considered are the expenses incurred in fishing operations, the actual cost incurred in getting their fish supply (in case of brokers), and the prevailing market prices (BFAR and BAEcon 1977:105–106).

Several observations were made in Navotas and other fish-landing areas and markets (Navera 1976:86–88). The fresher the fish, the higher was the price. Prices varied among species with the "first class" (Serranidae, *Caranx* sp., and *Chanos chanos*) getting a better price than second class (*Rastrelliger kanagurta, Nemipteridas,* and *Caesio* sp.) or third class (*Decapterus* sp., *Anadontosoma chacunda*, and Leiograthidae). They also varied among sizes with large-size fish commanding higher prices than smaller sizes. For the same species and degree of freshness, the prices of fish sold by brokers were lower than those sold by the buyer-sellers who bought fish from brokers and sold to other buyers. Prices charged by producers were lower than those charged by brokers. For species passing through more intermediaries, prices were higher.

If the buyer had a good credit standing, that is, he promptly paid his accounts, he was usually charged a lower price or was given priority in the award of sale over others who made the same price offer (or even higher) but had a poor credit standing. Closely linked with the credit standing was the honesty of the buyer. A buyer who sometimes delayed in paying his accounts, but was known to be honest, was usually given preference in the award of sale over other buyers who were not considered honest.

Also linked to credit standing was the bargaining power of the buyer. Bargaining power could be highly correlated with credit standing and lot size: the bigger the lot size, the better was the credit standing and bargaining power of the buyer. Related to this was the type of buyer. A wholesaler had greater bargaining power than the retailer because his usual lot size of purchases was also much greater than those of the retailers. However, bargaining power was also related to some other considerations, such as whether a buyer was a regular customer, a business associate, a friend, or a relative. In general, the greater the bargaining power of the buyer, the better was the price and preference given to him in the award of a sale. The price varied with the quantity of fish purchased: the larger the lot size, the lower was the price. However, the larger the volume of fish available in the market, the lower was the price. With lower supplies, prices tended to rise.

Problems and Policies

Several problems confront the present fish-marketing system in the Philippines. First is the lack of adequate fish-landing areas. A dispersed fish-marketing situation still prevails in the municipal-fisheries sector where the catch is landed in fishing villages. On several designated landing areas, however, facilities such as ports, ice plants, and cold storage facilities are inadequate. Because of the high perishability of fish, ice plants and cold storage facilities are critical.

The poor location of some ice plants further aggravates the inadequacy of supply. The distribution of ice plants shows a high degree of concentration in Metro Manila, which accounts for 53% of the country's ice-plant operating capacity while contributing only 12% to total fish production. Region IV, the largest contributor to total fish production at 277 000 t, had an ice supply for only 159 432 t (Kampitan 1979).

The second problem is inefficient collection and distribution of fish, which results in areas of fish surpluses — such as Southern Luzon and the Visayas — and areas of deficit — such as Northern Luzon and some provinces in Mindanao — with consequent large price differentials. Establishing fish plants or collection centres in surplus areas as well as marine and overland refrigerated couriers linking surplus to deficit areas could help rationalize distribution.

A third problem is the involvement of a long chain of middlemen in fish trading. Although middlemen are necessary, they tend to inflate marketing costs. A recent unpublished study of the Philippine Fish Marketing Authority (PFMA) showed that fish is traded at least four times before it reaches the consumer. In the process, prices increase by as much as 200%. Fish quality also suffers because of the long marketing chain.

To develop the fishery industry and solve its marketing problems the government has implemented a number of policies and programs. Created as the marketing arm of the fishery industry, PFMA is intended to promote the development of the fishing industry and improve efficiency in fish handling, preservation, marketing, and distribution through the establishment and operation of fish markets and the efficient operation of fishing ports, harbours, and other marketing facilities.

NFPFM is the country's premier fish market. There are plans for 10 additional commercial fishing ports and market complexes to be constructed in the near future. These will be located among other areas in Sual (Pangasinan), Camaligan (Camarines Sur), and in the cities of Lucena, Iloilo, and Zamboanga. To complement these commercial fishing ports, municipal ports are similarly programed for construction in coastal municipalities that are traditional or potential surplus areas.

Appendix: Types of Sellers and Buyers in Philippine Fish Markets

Sellers, producers or their representatives, may be classified into the following types:

- Commercial fishing-boat operators who operate fishing boats with a gross tonnage of at least 3 tons;
- Municipal fishermen who operate fishing boats of less than 3 tons;
- Middlemen who operate carrier boats and buy fish from fishing-boat operators at the fishing grounds to sell at landing areas;
- Fish-pond operators who usually produce milkfish or shrimp, or both, from fish ponds;
- Fish-pen operators who produce milkfish or shrimp, or both, from fish pens;
- Truckers, who may be producers or middlemen, who bring in fish catch from other places by truck.

The various types of buyers are classified according to their characteristics and functions as:

- Wholesalers are merchants who buy fish, usually in fairly large quantities, either from producers or brokers, and sell them to other middlemen (but not to the ultimate consumer);
- Retailers are middlemen who sell their fish purchases to the ultimate consumers, mostly in the retail markets;
- Wholesaler–retailers are middlemen who buy fish in fairly large quantities and sell them to other middlemen and also to the ultimate consumers;
- Buyer–sellers, strictly speaking, are also wholesalers as described above but are differentiated from them as operating within the confines of the fish-landing area;
- Institutional buyers buy fish for consumption in such institutions as hospitals, restaurants, etc.;
- Processors buy fish in bulk for processing into salted dried fish, *tinapa*, fishmeal, etc.;
- Exporters buy fish for export to foreign markets;
- Canners buy fish for canning; and
- Final consumers buy fish for household consumption.

Social and Institutional Constraints

Impact of Buddhism on the Small-Scale Fishery of Sri Lanka[1]

Sunimal Fernando, Luxman Devasena, R.M. Ranaweera Banda, and H.K.M. Somawantha

Sri Lanka is a predominantly Buddhist country where Theravada Buddhism has dominated as the basis of ethical values throughout the past 22 centuries. Nonviolence to living beings is a cornerstone of Buddhist theory — it is a vital component of the state of spiritual attainment toward which all Buddhists are expected to strive. However, in Sri Lankan society — as in all Buddhist societies — the slaughter of animals for food is a part of empirical reality.

Sociological studies of Buddhism by scholars such as Max Weber have prompted a number of development sociologists to conclude that Buddhism is a constraint to economic development. Fisheries is a somewhat extreme case where Buddhist ideology on killing living beings can be expected to exert a powerful constraint on the development of the sector by impeding entry of capital and labour.

If Buddhism does not look with favour upon persons who are engaged in the slaughter trades, of which the fishing industry is one, we would expect that, if Buddhists — and even non-Buddhists, who are subject to all the cultural influences of Sri Lanka's staunch Buddhist environment — could earn no more from fishing than from other occupations, they will choose other occupations that do not conflict with accepted religious norms. In other words, we would — logically — expect them to earn more than their opportunity costs as a compensation for choosing a slaughter trade as their occupation over their next best alternative.

Fisheries in Sri Lanka are open-access resources: anyone who wants to take up fishing is legally free to do so, provided he can meet the minimum capital requirements for purchase of craft and gear. Open-access means that, through entry of capital and labour, excess profits are competed away until each fisherman earns from fishing an income equal to the opportunity cost, i.e., as much as could be earned from the next best alternative occupation. However, when income levels of fishermen in Sri Lanka are compared with those of persons engaged in peasant agriculture, it is clear that both capital and labour earn much higher returns in the fishery than in peasant agriculture (see Munasinghe, this volume, p. 73). However, this will remain so in the future only if factors that constrain the flow of capital and labour to the small-scale fishery continue to operate.

This paper investigates whether Buddhism, as it is commonly understood, is one such major constraint, and if so, whether it would continue to be a constraining influence in the future. Although we examine the Buddhist doctrinal position with regard to the taking of life, our study of its empirical effect on the socioeconomic behaviour of fishermen and nonfishermen is confined to the present. What the effect of these noneconomic factors was on the past economic behaviour of fishermen and nonfishermen, whether the effects are changing, and what the effects are likely to be in the future are problems that fall outside the scope of the study. However, the relevant attitudes of the younger age groups are compared with those of persons belonging to older age groups.

The Buddhist Doctrinal Position[2]

Given that the very first of the Five Precepts calls on Buddhists to refrain from killing living

[1]An earlier version of this paper, presented at the IDRC Regional Workshop in Singapore on 19-22 May 1981, was condensed by Henry De Mel, Research Officer, Marga Institute, Colombo, Sri Lanka.

[2]This section is based on two studies specifically prepared for this project by two Buddhist scholars (Devasena 1980; Indraratana 1980).

beings, yet fishing involves the slaughter of fish, is fishing compatible with Buddhism?

The emphasis in Buddhism (when properly understood) is not on group behaviour but on "right action" by the individual. Sooner or later, the individual becomes aware of the forces that compel him/her to adopt modes of conduct through which some or all of the Precepts are likely to be broken, in spite of the intellectual knowledge that conformity to the Five Precepts is desirable.

It is unlikely that all individuals will arrive simultaneously at a comprehensive realization of truth. There will be advanced and higher evolved persons at one end of the scale and, at the lower end, less advanced persons, some of whom participate in slaughter trades, army service, manufacture and sale of deadly weapons, etc. Enlightened Buddhists will accept the social reality of there being (among others) people engaged in slaughter trades such as fishing, look at their problems sympathetically, and do everything possible to help them economically and uplift them spiritually.

The raison d'être of Buddhism is that society is composed of individuals who are not perfect and are involved in economic processes that perpetuate ethical shortcomings but that such individuals should be shown the way to free themselves. If all members of society were gifted with ideal self-restraint and self-realization, they would have been able to refrain from killing, stealing, etc. under all circumstances and observe the First and other Precepts with the greatest care. However, human minds are far too complex for the spontaneous display of straightforward responses of this type.

The very fact that nonkilling is stressed in the Precepts presupposes the existence of slaughter trades such as fishing and of people who are engaged in them. The Buddhist world-view takes into consideration the present life of those who are engaged in fishing and sets it in the context of a previous life-series where actions had been done through ignorance of spiritual truth. As an end-result of such actions, people (in our case, fishermen) have been conditioned to be born into a set of circumstances in which participation in slaughter trades such as fishing could not be evaded.

No one argues that catching, and hence killing, fish is a justifiable activity for a Buddhist who is seriously endeavouring to obtain release from the round of birth and rebirth. Yet it is useful to remember that the force of *Karma* accumulated in past lives brings about birth in environments where participation in the fishing industry is unavoidable or, at the least, likely. What is necessary, therefore, is not the mere giving up of the occupation of fishing but abandonment of the root cause, craving, which has conditioned birth in the "unsatisfactory" environment of a family of fishermen. Buddhists are asked to cut down craving and not merely solitary instances of its outcome, to cut down the entire forest instead of felling just a single tree (*Dhammapada*, stanza 183).

The *Maccha Sutta* should inspire us to see things in their proper perspective. That *Sutta* refers to an occasion when the Buddha was on a journey in Kosala accompanied by His disciple monks. On the way, He noticed a fisherman slaughtering and selling fish. Without admonishing him or even speaking to him, the Buddha directed the attention of the monks toward the fisherman. However, in this conversation with the monks, He spoke disapprovingly of the slaughter of fish. It is noteworthy that he observed the economic plight of fishermen and others who were in slaughter trades.

The position today is in many respects analogous to that which existed in the 6th century BC. Perhaps new technology introduced in the modern era has resulted in increased production, but the pattern of fish producers and fish consumers has not altered. We are free either to be vegetarians or to partake of meals with fish. Realizing our inability to eradicate fishing and other slaughter trades altogether from society, we can individually mind our business of engaging in spiritual endeavour, assisting wherever possible other individuals who are similarly on the spiritual path of progress toward *Nirvana*.

Thus, it is clear that, although doctrinally the slaughter of fish was never considered compatible with the First Precept, fishing as an occupation has been a social reality in our country throughout the centuries. Even though the Buddha could, through His influence with the kings of Kosala and Magadha and high-ranking citizens, have had the slaughter trade prohibited by royal decree, He did not do so.

Today, there are non-Buddhists as well as individuals from traditionally Buddhist families engaged in the fishing industry. Most of those Buddhists intellectually accept the position that there is a breach of the First Precept when they take part in the slaughter of fish. Apparently, their participation in the fishing industry is not a constraint on their adherence to Buddhism, or vice versa.

The Sri Lankan Empirical Reality

The data used in this section were gathered in selected fishing and nonfishing villages in 1980 as well as taken from a survey conducted by Fernando (1975) at Tangalla. Questions designed to reveal both fishermen's and nonfishermen's understanding of and attitudes to Buddhism and its relationship to the fishing industry were posed to samples of respondents. The 1975 survey covered a sample 587 households in Tangalla and the 1980 survey covered a sample of 1985 households in seven fishing and nonfishing villages. These villages were Huruluwewa and Nawakiriyawa, settlements in irrigated areas; Walgampaya, a hill agricultural village; Kadurupokuna, a low-land agricultural village; Tangalla, a coastal urban centre; and Kudawella and Mawella, southern coastal communities.

At Tangalla, 448 nonfishing household heads and 139 fishermen of the Karawe caste were asked whether they consider fishing incompatible with Buddhism. Of the nonfishermen, 76% answered yes, only 13% answered no, and the rest were unsure. Of the fishermen, 77% answered yes and 15% no. These findings were corroborated by the 1980 survey in two neighbouring fishing villages, Kudawella and Mawella. Two conclusions may be derived from these responses: first, there is no significant difference between fishermen and nonfishermen in their perception of the conflict between Buddhism and the fishing occupation; and second, fishermen's perception of the incompatibility of religion and fishing has neither prevented them from entering the fishery nor induced them to leave it.

To see if the fishermen and nonfishermen had the same perception of the consequences of violating the religious code, they were asked if a fisherman after death could be born in a good environment. Of the nonfishermen, 18% answered yes and 45% no, compared with 20% and 40% of the fishermen. Again, the difference in answers would indicate that Buddhism does not constrain occupational choice and hence entry into the fishery.

The 1980 Marga Institute survey of Kudewalla and Mawella had similar results but also revealed that younger fishermen tended to disagree with older fishermen. The younger fishermen do not seem to subscribe as rigidly to the idealistic Buddhist position on this matter as do the older fishermen. To the question "Is the fisherman destined to be reborn after death in *Apaya* [purgatory]?", only 31% of the 15–35 year-old fishermen answered yes compared with 61% of the 36–50 age group and 72% of those over 50 years of age. However, the less rigid religious views of the younger generation may indicate a liberalization of the traditional religious views or simply be a characteristic of youth that is modified with age.

The attitudes that influence fishermen empirically differ from the positions entertained theoretically. For instance, 91% of Buddhist fishery workers interviewed said that they dissuade relatives from being in the fishing industry for reasons other than the alleged sinfulness of this occupation. No concerted attempt is made by relatives to draw kinsmen away from the fishing industry. Indeed, in investing earnings and savings, most Buddhist fishermen give priority to investments in fishery activities and encourage their friends and relatives to invest in the fishing industry. More than 50% of fishermen in each age group gave considerable encouragement in this respect. Both younger as well as senior fishermen may believe that economic advantage is more important than religious considerations. Christian fishermen also encourage their friends and relatives to invest in the fishing industry. The empirical evidence reveals that, although Hindu fishermen entertain the hope of giving up work in the fishery industry, Buddhist fishermen operate in practice outside their theoretical frame. In the fishery sector, therefore, the theoretical positions on religion held by people do not seem to affect their economic behaviour significantly.

Once again, if Buddhism influences the economic behaviour of Buddhists when they are confronted with the opportunity of obtaining other work bringing equal income, they should be willing to give up fishing. Our study, however, found that Buddhist fishermen are not anxious to undertake such alternative work that pays just as well (Table 1).

Because Sri Lankan fishermen complain that they cannot save much because they receive their income in small and fluctuating daily installments, unlike the farmers who receive most of

Table 1. Correlation coefficients[a] between fish rent and size of fishing assets, Bangladesh.

Class	Between rent and boat size	Between rent and net size
Lower artisanal	0.514***	0.618***
Upper artisanal	0.653***	0.629***
Protocapitalist	0.260	0.222

[a]Asterisks indicate significance at 1% (***) level.

their income once or twice a year, we offered fishermen the hypothetical choice between fishing and some alternative occupation that pays the same income but irregularly in large sums. The percentage of fishermen who would change their occupation under such conditions rose in all four religious groups, although most dramatically for Christian fishermen. Changing the hypothetical alternative to a "slightly higher income but less sense of adventure" increased the percentage of both Buddhists and Hindus who would change — obviously both are in fishing for the money. A reduction of 50% in earnings from the hypothetical alternative (coupled with more income security) dramatically reduced the percentage who would switch in all four groups (Table 1). On the other hand, although Buddhist fishermen were not as anxious to abandon fishing as Hindu fishermen, they were certainly more eager to do so than either Muslim or Christian fishermen, for whom only the prospect of higher or accumulated income would be motive to move out of fishing in any significant numbers (Table 1).

The income of Buddhist fishermen is substantially higher than that of Buddhist agricultural workers. Why then have rural labourers not joined the open-access fishery to obtain a share of the higher incomes there? To what extent are the income differentials being maintained by the "stigma" allegedly attached to fishing by Buddhism? Between 11 and 45% of nonfishermen in four nonfishing and one fishing villages felt that fishing was not a fit occupation for Buddhists. However, among the young and poor — income of less than 300 LKR/month (15.63 rupees [LKR] = US$1) — very few thought that fishing was an occupation that they should not practice as Buddhists. None of the three caste groups studied considered fishing a low-status occupation, indeed the Karawe caste indicated a partiality for fishing.

The responses from the five villages to these questions underline the importance of economic factors. In villages where land and irrigation water were readily available (e.g., Huruluwewa and Nawakiriyawa), very few wished to join the fishery. Also members of the higher-income groups tended to reject fishing as an occupation for them. Fishing was not considered a low-status occupation by any of the age groups in any significant way.

Most of the respondents, regardless of age and location, except at Huruluwewa and Nawakiriyawa, would take up fishing if an income higher than that earned through land-based employment were guaranteed. Most of the under-30 age group in all villages except Nawakiriyawa would join the fishing industry if training facilities and protection from risks were provided. However, in two older age groups, comparatively fewer people would do so.

To the question "are you reluctant to become a fisherman because fishing is considered more risky than land-based occupations," most respondents in all age groups and locations (except at Walgampaya and Nawakiriyawa) answered yes. The pattern of responses from the three income categories did not diverge significantly from that of the age groups, except at Huruluwewa where only 19% in each income category answered yes. The risk factor seems to be a greater deterrant for those in coastal villages or in the vicinity of the coast than for persons living in hinterland villages such as Huruluwewa.

Most people living in marine fishing villages or in villages that adjoin such villages felt that income from fishing was not insecure, whereas most of those in interior villages (where no inland fishery existed) felt that it was insecure.

Individuals in different age groups from the five villages who had not inherited land or other means of earning a living were asked if they were willing to take up fishing. Most respondents (especially the young) at Walgampaya, Tangalla, and Kadurupokuna said that they were ready to engage in fishing. Most villagers in various age groups were willing to join the fishery because they expected they could earn a better income than in another vocation. However, the respondents of Huruluwewa placed their hopes on agriculture. Lack of experience makes villagers, especially those below 30 years of age, hesitant to join fishing, but personal aversion to fishing was more prevalent in the older generation.

We have attempted to analyze the willingness or otherwise of those who were without inherited property or other sources of income to become fishermen. Our investigation was confined to four nonfishing villages and a section of the nonfishing community of a Buddhist fishing village. Our findings may be summarized as:

- Low income earners and small-scale traders indicated that they are willing to become fishermen.
- Many villagers who belong to the Goigama (farming) caste in all these villages, except in Huruluwewa and Nawakiriyawa where adequate irrigation facilities are available, expressed their willingness to join the fishing industry.

- Many villagers who are high income earners engaged in traditional services showed aversion toward fishing or investing in the fishery.

Small-scale traders who are willing to take up fishing must be distinguished from large-scale entrepreneurs operating on a national scale. In the case of the small-scale trader, behaviour is motivated more by economic needs than by religious considerations. On the other hand, the large-scale entrepreneurs are under the social compulsion of having to conform to the time-honoured cultural pattern, which generally implies a typically Buddhist life style. Hence their reluctance to swerve from the theoretically accepted Buddhist way, even in the matter of making investments.

An Alternative Hypothesis: The Closed Community

If we are correct in proposing that a cultural–religious factor does not present a major constraint to the flow of capital and labour into the industry at the level of small-scale enterprise, some other factor must be a constraint.

The Sri Lankan coastal fishing communities are, in general, closed communities that do not allow persons from outside the community to obtain access to the fishery resources that each community exploits as a group. Thus, no outsider will be allowed to anchor or beach a fishing craft along the shoreline belonging to a coastal fishing village; labour recruitment for boat crews is also from within the closed community; and ties of kinship and marriage link the different fishing villages to one another. With such restrictions on entry, economic returns to capital and labour remain much higher than their respective opportunity costs. As a result, capital formation in a fishing community takes place at a relatively rapid rate and, with access to loans on easy terms from the state banks for the purchase of modern craft and gear, the fleet size of a modernized fishing village also increases rapidly. It must be noted, however, that this rapid capital formation is not in large-scale trawlers and purse seiners as in other countries such as Thailand, but in small-scale fishing gear and motorization of traditional craft.

Logically, a closed fishing community with a high rate of capital formation must experience — at some stage — a shortage of labour and, at this point, the closed nature of the community will begin to break down. The closed community will now have to open itself and recruit labour from outside for its enlarged fishing fleet. The outsiders thus recruited as crew will, in the course of time, win acceptance in the local fishing community, perhaps marry from within it (generally across the boundaries of a caste), and thus become insiders in what once was a closed fishing community that jealously guarded its resources from outsiders.

Once the closed nature of the community begins to break down, the flow of labour and capital will gather momentum until the returns to capital and labour in the small-scale fishery fall to a level equal to their opportunity costs. The very early signs of this process are already visible at Thoduwawa and Mattakotuwella — two neighbouring fishing villages on the western coast where some boat owners own expensive private cars and air-conditioned houses. The rate of capital formation in these two communities, especially during the decade 1970–80, has been so high that the fishing fleet has increased so much that the early signs of a labour shortage are now visible. In response, persons from outside the village are beginning to be recruited as crew members.

Although this opening-up of the closed community brings about an individual gain for the craft owner, a "social cost" is incurred at the same time. By breaking the constraint to entry, the community as a whole loses because the number of competitors on the fishing grounds will eventually increase. In one instance, a crewman recruited from Kurunegala (50 km away) has married a local girl and now intends to buy a boat himself and operate it from Thoduwawa. Being accepted in the fishing community as an insider, this former outsider is now in a position to provide a "sociological bridge" across which his relatives from Kurunegala may enter the fishery at Thoduwawa. There are at least four such cases at Thoduwawa and Mattakotuwella, indicating the start of what may turn out to be a critical sociological process, which in the long run could grow into a free flow of capital and labour from the agricultural sector to the fishery sector. This will depress the high rates of return to capital and labour now enjoyed in the small-scale marine fishery, and ultimately lead to the overexploitation of the fishery resources.

Summary of the Empirical Findings

The empirical evidence indicates that, although both Buddhist fishermen and Buddhist peasants clearly perceive Buddhism as a religion that takes an unambiguous position against the killing of living beings (including fish), this does not totally alter their economic behaviour to make it consonant with their religious perceptions. Further, the economic behaviour manifested in the willingness to either enter or remain in the fishing industry has not been powerful enough to transform religious doctrine by reinterpreting or restating the Buddhist doctrine on the matter of killing.

However, the evidence also indicates a general reluctance to engage in this sinful occupation on the part of a substantial proportion of the social categories sampled. On the other hand, there is also evidence of the following economic behaviour:

- A definite desire on the part of Buddhist fishermen to remain in the fishing industry even if alternative employment with equal or enhanced monetary returns is provided.
- A desire on the part of the relatively lower-income earners in Buddhist agricultural villages where land or water, or both, are in short supply to enter the fishing industry if an economic incentive is given.
- An even greater eagerness on the part of the youth in nonfishing villages that experience a scarcity of land or water, or both, to enter the fishing industry provided there is an economic incentive.
- An absence of any type of prejudice against entering the fishing industry among Goigama caste peasants provided they see an economic incentive for doing so.

Peasants with viable land holdings under major irrigation schemes (e.g., Nawakiriyawa and Huruluwewa) and skilled workmen with a high income-earning capacity (e.g., masons and carpenters), by and large, showed a disinclination to enter the fishing industry. In contrast, peasants with relatively insecure sources of income (e.g., Walgampaya and Kadurupokuna) showed a much greater willingness to enter the fishery to earn higher incomes. The evidence also indicates that, other factors being constant, the younger generation is definitely more responsive to the economic incentive than to the cultural-religious constraint, by comparison to the older generation. Tamil-speaking Hindu fishermen comprise a category that seems to be most constrained by the cultural-religious factor.

Thus we can suggest that, with the exception of the Tamil-speaking Hindus, the cultural-religious factor presents no major constraints at the lower-income levels for recruitment of labour and capital into the small-scale fishery. However, although the economic factor outweighs the cultural-religious factor in determining economic behaviour among the lower-income groups, the reverse is true for the higher-income groups. Indeed, the higher the income, the greater is the tendency to move away from the fishery — despite the high rate of return to capital in the fishery sector.

Policy Implications

Although Sri Lanka has large-scale industrialists, commercial undertakings, and service industries, it has characteristically no large-scale fishing entrepreneurs. Sri Lankan politics have also never known a fisheries' lobby canvassing its interests among the decision-makers. It does not seem unreasonable to suggest that one major reason for this phenomenon lies in the cultural-religious impact of Theravada Buddhism at the higher levels of economic enterprise. If this is so, Sri Lanka's fishing industry may be destined to operate always at a small scale, a finding that has far-reaching implications for fisheries development in Sri Lanka.

The present position, however, serves to prevent the growth of both the precipitous dualism common in other fisheries, such as the Thai fishery (see Panayotou 1980b), and the overcapitalization and overexploitation that characterize other fisheries around the world. In the light of the limited resources, the loss of those with higher incomes to other activities permits the less well-off to get a share of the resource rents and move up the economic and social ladder. The present situation is therefore advantageous to the Sri Lankan small-scale fishery.

Because there is an expressed desire to enter the fishery by lower-income earners in Buddhist hinterland agriculture villages when land or irrigation facilities, or both, are scarce, efforts to develop inland fisheries will not meet with any significant cultural-religious constraints so long as the target groups belong to the lower-income categories. However, where land and irrigation water are available, inland fisheries are unlikely to succeed.

The greater eagerness shown among youth, compared to the older age groups, in the hinterland agricultural villages to take up fishing indicates that younger persons are likely to be more responsive to inland fishery and aquaculture development programs.

Fishing Rights, Production Relations, and Profitability: A Case Study of Jamuna Fishermen in Bangladesh

Mahbub Ullah

This paper is an outcome of a survey of the fishing households in a cluster of 11 villages — Joynagar, Koitala, Natun Bharenga, Raksha, Ghior, Maldapara, Nakalia, Punduria, Painapara, Charpara, and Shainkapara — on the bank of the River Jamuna in the District of Pabna in Bangladesh. The unit of analysis is a fishing team usually led by the owner of the fishing boat(s) and gear. In addition to his own input of labour, the team leader organizes the fishing operations in the two seasons of the fishing year. The team leader has a decision-making role as to the number of extra crew to be hired in addition to his own family members, the number of days to be spent in fishing operations per season, the amount of money to be borrowed from the traditional moneylenders for financing the variable expenditure of the fishing operation, and the segment of the river for the team's fishing operations. Fishing grounds are leased out annually by the government to the highest bidder through an auction.

The analytical structure of this paper is built on a fundamental premise that the most important element in production is work: mankind finds its existence conditioned by labour. The conditions that generally govern production must be differentiated for a specific economic society so that essential differences are not lost in the general uniformity that exists because the subject — mankind — and the object — nature — remain the same. This is why our approach was to identify the production organization in fishing as an expression of various relations — in labour-hiring, lease, and credit — that exist in traditional fishing as occurs on the River Jamuna.

The term "relations" is used instead of "markets" in relation to labour, leasing, and credit because the market, as understood in mainstream economics (whether perfect or imperfect), is completely absent in this line of economic activity. This is because the relations with labour, lessee, and moneylender are determined by an interaction of sociopolitical power and economic power so that economic power and political power are not separated — a crucial characteristic of modern market economies. A brief description of the foregoing relations found in the fishing activities in the River Jamuna will show the symbiotic nature of political and economic powers pervading these relations.

Labour Hiring Relations

The work organization of the fishing team in its smallest form is composed of available working members within the family and in its largest form may even consist of 40 hired labourers. The team leader invariably owns boat(s) and gear and the labourers, who do not possess fishing boats, may own nets. The fishing-team leader also works as a labourer within the fishing team — a role that is similar to that of the master craftman in a feudal guild who acted both as a master of an artisan activity and as a worker. Thus the functional role of the entrepreneur is not separated from the functional role of the worker. The residue of the output left with the fishing team after payment of the fish rent to the lessee is distributed among the inputs of labour, boat, and net on the basis of a traditionally determined share (see appendix).

The labourers on the fishing team are usually recruited from the neighbourhood of the place where the team leader resides. Kinship ties (both blood kin and fictive kin) and factional loyalties play a significant role in the hiring labour for the fishing units. Thus direct remuneration for labour services does not always reflect the total compensation for such services as is the case with market economies. To estimate such total compensation, the totality of exchanges taking place in the sociocultural milieu must be considered; however, this complex phenomenon is outside the limited scope of this paper.

The fishing team formed around the leader usually lasts for one fishing season. There are two fishing seasons, the dry fishing season (mid-August to mid-February) and the wet fishing season (mid-February to mid-August). As the fishermen want to even up the "luck" factors in fishing, they tend to change teams from one season to the next.

Lease Relations and the Nature of Property Rights

The British rulers introduced the system of permanent settlement for revenue administration and management of land in Bengal in 1793. This system and its consequences on the "man behind the plough" have been examined in detail by the economists and historians, but little light has been thrown on the tenurial system of water bodies. In this connection, the term *Resumed Mahals* or Resumed Estates used in the literature of revenue settlement is a pertinent issue.

The *Resumed Mahals* paid, or were liable to pay, revenue to the government, but they were not permanently settled by the holder. This special type of revenue settlement was designed for land areas formed by river alluvium after the introduction of permanent settlement. Legal instruments for the administration and management of the *Resumed Mahals* were created by the British rulers under the Regulation II of 1819 and Act IX of 1847. Normally, the *Resumed Mahals* were settled on temporary leases with the *maliks* or proprietors. On the recusancy of the proprietors, however, the contract or lease could be cancelled and fresh lease-contracts settled with other individuals. The right of the lease holders was limited to the creation of subtenures intermediate between themselves and the cultivators; and in creating such subtenures, they were not permitted to interfere with the legal rights of the latter. They had also, during the term of their leases, an absolute right to dispose of unoccupied lands. If the lease holder had not been the proprietor, the resettlement when the lease expired was made with the proprietor should he apply; but, in his absence, preference was given to the former leaseholders over newcomers.

The fishery tenures bore close resemblance to the *Resumed Mahals*. They came to be known as *jalmahals* or *jalkars*, which were resumed as the property of the estates on the principles laid down in the Government Order 341 of 12 September 1859. The tenures were let out on temporary leases and most of the leaseholders sublet the fisheries to actual fishermen on terms similar to those on which they themselves held the fisheries from government.

The tenurial arrangements with regard to the fisheries have not been changed in essence since the British days and the existing system still has much resemblance to the system of resumed estates. All the inland natural water bodies, with a few exceptions, are now within the public domain and their use for fisheries is subject to the approval of the Directorate of Fisheries. The water bodies are divided, administratively, into segments and, within these segments, the exclusive right to fish is auctioned by the government to the highest bidder for leases that last 1-6 years. The lessee, usually a fish merchant or moneylender, negotiates with the fishermen for the right to fish on payment of a cash rent or share of the catch.

Since 1973, when the Directorate of Fisheries took charge of leasing arrangement from the Ministry of Land Administration and Land Revenue, the system has been slightly modified to give preference to fishermen's cooperatives in leasing at a negotiated rent based on average rental over the preceding 3 years. Because this modification in the leasing system did not involve the genuine fishermen in the fishing cooperatives, as had been expected, and led to widespread mushrooming of pseudo fishermen's cooperatives in which control was in the hands of the private lessees, the Directorate of Fisheries decided in 1981 to switch back to the system prevailing before 1973.

The fishermen of Pabna villages have been reported to be engaged in fishing in different *jalkars* or segments of the River Jamuna. The following types of property rights over different segments of the river were observed:

- Leased out directly by government through auction to private lessees;
- Leased out by the government to the fisheries cooperative societies;
- *Debottar* properties; and
- Privately controlled water bodies.

Property rights of the first and second types have already been discussed. The *debottar* water segments are fishing waters reserved to support the worship of Hindu deities. These are rent-free tenures, accepting and subordinate to them are subtenants similar to those already described. Privately owned water segments are *maurasi jalkars* held at a fixed rent in perpetuity with a written stipulation that the heirs of the original holders shall succeed to the tenures.

The system of leasing out different segments of the river has been the cause of conflicts and sometimes of bloodshed among different lessees because of disputes over the line of demarcation between water segments. Any fishermen who are found fishing in the disputed waters are made to pay rent to all parties involved in the conflict. If they refuse to fulfill the demands of one of the parties, they may be subjected to physical torture.

Clearly, fishing in the River Jamuna is not an open-access affair. Beside the point that the existing leasing arrangement is a prima facie case of partial transfer of property rights through the mechanism of contract, we can reasonably argue that such de jure transfer of partial rights has close proximity with the economic consequences of outright transfers. Various types of barriers to entry into the lease market eliminate the insecurity generated by the legal requirement for the renewal of leases from time to time. The lessees are a highly specialized type of people because it is not easy for anybody possessing the required amounts of money to pay for the bid to take part in this activity. To make the most of this business, the lessee must, by policing them, ensure that no fisherman can evade the payment of the fish rent. The policing cost, however, is not equal for all intending bidders: lessees coming from the vicinity of a particular river segment have an extra advantage in recruiting and maintaining a private police force, locally known as *lathials*, at a comparatively low cost. Deeply entrenched roots in the local power structure, low cost of familiarization with the recruits mobilized from the lessee's own locality, and a lower remuneration requirement for these recruits — because of the absence of relocation costs and a greater degree of control over them derived from lessee's local power position — give lessees coming from the vicinity of the leased segment of the river an advantage over outsiders.

A low policing cost for a particular set of lessees is the most crucial element. It enables them to perpetuate their leasing rights, and, therefore, eliminates insecurity arising from the system of temporary leasing. Moreover, continuous activity in this field by a particular set of people gives them an added advantage in manipulating the government bureaucracy empowered with the management of fisheries. The government bureaucracy also feels assured in renewing the lease to them as they are the type of people who would be least likely to default in paying the government dues.

Thus, the lease market in the River Jamuna fishing is clearly not as competitive as it may at first appear from the leasing arrangements. The overall advantages of low transaction costs exclude the fresh fortune seekers in this line of activity. Perhaps, this differential nature of transaction costs for different sets of people explains the emergence of a stable group of lessees in River Jamuna fishing. Our observation in this regard lends credence to the fact that leasing *jalkars* has become a hereditary occupation of this group of people.

It has been observed that, of a total of 52 fishing-team leaders, 24 paid a share of the catch as fish rent during the winter season of 1980. The rest of the fishing-team leaders paid a fixed amount of cash rent, which was an insignificant proportion of the gross value of the catch. It has been further observed that the share rent varied between one-ninth and one-third of the gross amount of catch. The team leaders account for this variability in the share rental in four ways.

First, if a certain *jalkar* carries a substantial amount of biomass, the share of the catch charged as a rental is increased.

Second, if a fishing-team leader happens to be powerful through socioeconomic influence over the community, he may be given a partial responsibility for policing over the fishermen. As a reward for this service provided to the lessee, he is charged a lower share as rental.

Third, the share of the catch charged as rent by the lessee has some correspondance with the level of effort exerted by a fishing team. A greater level of effort is associated with a greater amount of catch charged as rent.

Fourth, fishermen's cooperatives with leasing rights generally charge a fixed amount of money as rent from the fishing teams for a particular fishing season. This appears to be the practice of those fishermen's cooperatives in which genuine fishermen are involved in the management.

Fishing Rents, Bionomic Equilibrium, and Returns to Labour

For both the lower and upper artisanal classes[1] of fishing teams, the rent paid is positively correlated with the size of the boat and

[1]For definitions of the classes, see section on stratification of fishing team leaders.

size of net (Table 1). For the protocapitalist class, however, it is weakly correlated ($P > 0.10$) with size of boat or of net. For members of this class, the size of the boat or of fishing gear do not have significant association with the rent paid as a proportion of the gross value of output. It is quite possible that they bear a burden of concealed rents in the form of shared policing cost, but they also enjoy a greater degree of socioeconomic power within their own community, because they are at the highest stratum of the power pyramid.

It may be conceded that the lessees do not impose any "effort condition" on the fishing teams to conserve or add to the existing stock. However, the overall nature of the property rights and contractual arrangement between the concerned parties have important implications on the stock of fish resources in the River Jamuna. Many points favour the hypothesis that the Jamuna fisheries have not yet reached the undesirable state of a bionomic equilibrium.

- The River Jamuna is not an open-access fishery. An open-access situation arises when there is a failure to establish contract and prohibitive transaction cost, and on the River Jamuna there are contractual arrangements among the concerned parties — government, lessee, and fishing team. The fishing team derives the right to fish on a promise to pay a stipulated amount of money or share of catch as rent.
- Rents are fixed either in relation to the fishing assets deployed for fishing or to the extent of the policing cost borne by the team leader. Together they act as a positive check on an undesirable increase of fishing effort.
- Widespread prevalence of the system where rent is a fixed share of the catch also limits the fishing effort. As many as 27 of 52 fishing teams in our survey are reported to be involved in share fishing. This means a share of the fishermen's incremental catch goes to the lessee, therefore affecting the marginal conditions. Because of the lessee's take and the declining incentive arising from it, the cost of fishing is pushed upward. This brings in the compulsion to limit the fishing effort.
- Only 13 of 52 fishing teams come from the Muslim community. The socioeconomic process of marginalization has caused the Muslims to adopt fishing as one of their occupations as a strategy of survival. It has been observed that these new entrants into the occupation of fishing have yet to develop an occupational ethic for fishing, for example, they do not maintain an optimum mesh-size as is carefully done by the low-caste Hindu fishermen.
- Caste restrictions prohibit the traditional Hindu fishermen from changing their occupation and this absence of mobility has made them develop an occupational ethic through protracted trial and error. Because they are destined to remain as fishermen, they had to adjust their fishing practices to the reproductive behaviour of the fish. They have come to learn that overexploitation causes depletion of fish resources, which, in turn, depletes the original fund of their consumption.

In contrast to the Hindu fishermen, Muslim fishermen have occupational mobility that allows them the freedom to explore other income-yielding opportunities. The average daily wage received by the Muslim fishing labour of the upper artisanal group, during the winter season of 1980, was 9.45 BDT (15.15 takas [BDT] = US$1) whereas that of the lower artisanal group, who were purely family labourers, was 7.84 BDT as the value of marginal product of labour (measured in terms of standard 8-hour working days). This compares with the daily wage of the agricultural workers of about 10 BDT given in the Yearbook of Agricultural Statistics (Bangladesh, Bureau of Statistics 1980). Unfortunately, the Yearbook figure does not refer to the length of the working day of the

Table 1. Percentages of Buddhist and non-Buddhist fishermen willing to switch to alternative occupations, Sri Lanka, 1980.

Alternative proposal	Buddhists (384)[a]	Hindus (216)	Muslims (108)	Christians (296)
Same income	45	68	19	4
Same income but received in lump sum	53	89	30	44
Slightly higher income but less sense of adventure	57	94	46	41
Half as much income but more secure	20	36	4	11

[a]Values in parentheses are sample sizes.

agricultural labourers but they usually work 10 hours/day. Thus, return to labour per working day in fishing does not compare unfavourably with that in agriculture.

Apparently a lower value of marginal product of the family labour in fishing should not surprise us either. People in Bangladesh society tend to attribute higher value to self-employment than working for others. Notwithstanding the fact that there are some "pull" factors that attract a section of the Muslims alienated from their agricultural land into fishing, there are also some "push" factors (such as working for "food for work programs" and other developmental activities) that keep them from overcrowding the fisheries. Moreover, the value of the marginal product of a self-employed labourer is not a good estimate of the return to his labour: rather, the value of the average product of labour provides a more acceptable estimate of his return from labour. The value of the average product of self-employed Muslim family labour has been estimated at 11.2 BDT.

Dissipation of resource rent is a natural outcome of an open-access fishery. Cheung (1974) has drawn an analogy between Cournot's duopoly solution and the economic consequences of an open-access fishery. Cheung argues:

> The process is thus analogous to Cournot's duopoly solution with free entry, with ocean rent replacing monopoly rent, average product of labour in place of demand for product, and a positive wage rate in place of the assumed zero cost of production. Assume that fishermen labour is homogeneous and supply to the industry perfectly elastic, the complete dissipation of rent in equilibrium implies that the number of individual fishermen (or firms) approaches infinity, with each committing a trifling amount of fishing effort. . . . From the social point of view, the equality of the would-be average product of labour under private exploitation of the fishing ground and the wage rate implies that rent is entirely dissipated, and the corresponding (would-be) marginal product of labour being lower than the wage rate (marginal social opportunity cost) implies economic waste, if all costs associated with defining and policing private property in the fishing ground are ignored. Note that similar results can be obtained for share contracting between boat owner and fisherman, which is of some interest since we are informed that share contracts between boat owners and fishermen predominate in marine fisheries.

Cheung further points out that even if the assumptions of the foregoing theoretical construct are relaxed by dropping the assumptions of infinitely elastic supply of fishermen to the industry, of homogeneity in their efficiency, of absence of cost of entry and absence of institutional restrictions on entry, thus making the number of fishermen finite, the implications of the theoretical construct still remain valid.

The findings with regard to Jamuna fishermen are that the value of the average product of labour is higher than the value of the marginal product of labour and the wage rates for all the observations; and the fishing teams belonging to the three classes also earn positive rates of profit on the average (Table 2).

Thus, we may conclude that fishing in the River Jamuna is not an open-access affair. Profit-rate calculations and comparisons among the value of the average product, the marginal product, and the wage rate of labour indicate that the biomass level in the River Jamuna is not threatened with extinction. At the same time, we cannot say definitively that the biomass level is at its optimum. However, it may be conceded that the task of maintaining the optimal level of stock has been made easier by the existing property-rights structure. Some corrective

Table 2. Values (BDT)[a] of average product and marginal product of labour and wage rates in the River Jamuna fishery, Bangladesh, 1980–81.

Class	Number	Value of — Average product	Marginal product	Wage rate
Protocapitalist	22	12.30	8.56	6.79
		(17.40–4.16)[b]	(12.10–2.90)	(10.86–2.96)
Upper artisanal	13	17.45	12.29	8.63
		(36.46–4.81)	(25.36–3.34)	(17.00–3.19)
Lower artisanal (all)	17	17.23	11.08	7.06
		(44.44–5.76)	(20.61–4.03)	(8.00–6.48)
Lower artisanal (solely dependant on family labour)	12	14.26	9.93	7.03
		(29.62–6.68)	(20.61–4.03)	(7.03–7.03)

[a]US$1 = 15.15 takas (BDT).
[b]Values in parentheses are ranges.

measures are likely to produce more desirable results.

Credit Relation

Fishing is, by its very nature, highly dependent on credit because fishing operators need finance to run their fishing operations. The crucial role of finance is reflected in the sizable wage advances to the fishing labourers at the beginning of the fishing season. The fishing operators also need finance for preparing for the fishing operation. Mending fishing nets, repairing fishing boats, and procuring other materials for the fishing operation make the borrowing of funds indispensable. The fishing operators must depend solely on noninstitutional sources such as fish merchants, lessees, village shopkeepers, friends, and relatives for financing fishing expeditions because access to institutional sources is difficult. The wage-advance system enables the fishing operators to deduct from the wages of labourers an amount of money that turns wage advances into a consumption loan at a very high rate of interest. However, these interest rates are not uniform. The rate of interest for wage advances has a high mean and a very high variability. In this respect, labour hiring relations and credit relations become interlinked.

This interlinkage enables the fishing-team operators to shift the burden of credit onto the hired labourers as well as ensuring the continuity of the supply of their services throughout the fishing season. However, fishing operators who loan funds obtained from such sources as fish merchants and lessees remain obliged to sell their catch to their respective lenders at disadvantageous terms. Thus, the marketing relations are sometimes tied into credit relations. One may observe advance labour hiring through the credit relations between team leaders and labour and advance sales of the catch through the credit relations between fish merchants and team leaders.

On the whole, one may observe variable extents of interlinkages among the relations of right to fishing, labour-hiring relations, credit relations, and the disposal of catch relations. This phenomenon of interlinkages among various relations stifles the working of the forces of supply and demand and the mobility of the product and inputs within the system. Therefore, we cannot speak in terms of market rates of wages, interest, rent, or price of products in the short run.

Stratification of the Fishing Team Leaders

Statistical procedures for delineating stratification are the most frequently used methods for distinguishing classes. Differences in asset ownership or income is the most popular basis of this type of stratification, but the limitation of this procedure is that it does not enable us to make a real-life class analysis in a situation of conflicting relations. A stratification exercise having no contextual relation with the conflict-ridden situation of real life does not help us to understand the inner dynamics of the system and design policy measures to act upon the course of that dynamic development.

Patnaik (1976) has outlined a methodology for delineating stratification based on real-life conflict relations: what she calls the *E*-criterion or the labour-exploitation ratio. Patnaik bases her definition on the extent of use of outside labour in relation to the use of family labour, where

$$E = X/Y \qquad [1]$$

where X is net use of outside labour; and Y is household labour.

Patnaik defines X to include not only net labour hired in but also net outside labour (equivalent) appropriated through leasing relationships by converting net rental or crop share to equivalent man-days:

$$E = [(a_1 - a_2) + (b_1 - b_2)]/Y \qquad [2]$$

where a_1 is labour days hired in; a_2 is labour days hired out; b_1 is labour days taken through rent; and b_2 is labour days given as rent.

Based on field observations on fishing teams operating in the River Jamuna fishery, the terms a_2 and b_1 have been dropped because no fishing team leader was found to hire out family labour and to take in outside labour through rent during a particular fishing season. Between seasons, however, there are some changes in hiring in and hiring out of labour. Therefore, a separate *E*-criterion stratification exercise was carried out for each fishing season.

Following Patnaik's definition on the basis of the *E*-criterion, the fishing team leaders within the sample operating in the River Jamuna were classified into three economic classes:

- Protocapitalist class if $E \geq 1$;
- Upper artisanal class if $1 > E > 0$; and
- Lower artisanal class if $0 > E > -1$.

When the fishing-team operators in the sample are stratified on the basis of the *E*-criterion classification for two fishing seasons

Table 3. Numbers of fishing teams by economic class in River Jamuna fishery, Bangladesh, 1980–81.

	Season	
Economic class	I (Dry)	II (Wet)
Protocapitalist	23	14
Upper artisanal	13	17
Lower artisanal	17	22
Total	53	53

(Table 3), it is clear that there is fluctuation between seasons with an increase in use of family labour, or a decrease in use of outside labour, in the "wet" fishing season.

Stratification and Productivity

To delineate the relations between the *E*-criterion classes and their productivity, a production function analysis was undertaken using *E*-strata as dummy variables. The following Cobb-Douglas production function model has been specified:

$$Q = AE_1^{a_1}E_2^{a_2}E_3^{a_3}e^{b_iL_i}e^{\mu} \quad [3]$$

or in log-linear form:

$$lnQ = a_0 + a_1 lnE_1 + a_2 lnE_2 + a_3 lnE_3 + b_1L_1 + b_2L_2 + \mu \quad [4]$$

Where Q is output; E_1 is effort variable 1, representing the sum of all boat capacities used in an operation in maunds (1 maund = 36.94 kg); E_2 is effort variable 2, representing total capacity of nets used in the fishing operation in terms of weight; E_3 is effort variable 3, representing standard man-days (8-hour working days); L_1 is dummy variable representing the protocapitalist class ($L_1 = 1$ if the sample was from protocapitalist class and $L_1 = 0$ if otherwise); L_2 is dummy variable representing the artisanal class ($L_2 = 1$ if the sample was from upper artisanal class and $L_2 = 0$ if otherwise); and μ is an error term. The sample of the lower artisanal class was taken as the base.

The contribution of all three inputs (boat, net, and labour) in the first season was found to be positive but the regression coefficient of net was not significant statistically (Table 4). We may also note that, at a higher "labour-exploitation" ratio stratum, the catch of fish goes down significantly. This is consistent with theoretical possibilities because at a higher labour-exploitation stratum, net hired labour preponderates over family labour in the work organization and therefore concern for fellow members in the team and the cost advantages tend to be reduced. With the work organization composed of family labour alone, both the parameters of "concern" and "cost advantage" tend to be high (see Sen 1975). This effect, however, was statistically significant only in the step from artisanal to protocapitalist organization (Table 4).

Table 4. Regression estimates of the production relationship of River Jamuna fishermen, Bangladesh, 1980–81.

	Regression coefficient	Computed *t* ratios
Variables		
Boat (E_1)	0.379	2.776
Net (E_2)	0.018	0.356
Labour (E_3)	0.696	4.723
Protocapitalist (L_1)	–0.419	–2.190
Upper artisanal (L_2)	0.110	–0.597
Intercept	–2.978	–
Statistics		
R^2	0.763	–
Standard error of estimate	0.510	–
Degrees of freedom	48	–
F-value	30.920	–

Rate of Profit and Work Organization

What is the impact on rate of profit of different types of work organization where these are represented by the three economic classes or levels of "labour exploitation" mentioned earlier?

The rate of profit (P) has been defined as:

$$P = S/(C + V) \quad [5]$$

Where S is amount of surplus, defined as the value of output minus rent, obligatory payments (meaning payments to the lessee either in kind or in cash in excess of the payments spelled out through contract terms), interest paid for funds loaned for fishing, wages, depreciation cost of boat and net, and other expenses such as fuel, plus interest earned from wage advances; C is constant capital, which includes the depreciation cost of boat, net, and expenses like fuel; and V is variable capital, which includes wage cost for both hired and family labour.

The wages of the family labour of a fishing team employing both hired and family labour have been taken to be equal to wages paid to the hired labour. The wage cost of the pure family teams has been imputed from the average of wages paid to the hired labour during the respective fishing season: the assumption is that these family fishing units could hire out their fishing implements and employ themselves as hired labourers.

The terms "variable" and "constant" capital designate the two basic types of inputs that are measured by money expenditure in their respective roles as productive capitals. Each of these types of social capitals assumes specific characteristics when functioning within the process of production. Constant capital, as defined by Marx (1965:209), is:

> That part of capital which, as represented by the means of production, by the raw material, auxiliary material, and the instruments of labour, does not in the process of production undergo any quantitative alteration of value.

This refers to the role played by this capital in the production of value, that is, a given constant capital always transmits to the value of the output its own precise value equivalent — this is why it is designated as constant capital. The Marxian concept of variable capital refers to:

> That part of capital, represented by labour power, which does in the process of production undergo an alteration of value. . . . It both reproduces the equivalent of its own value and also produces an excess, a surplus value, which may itself vary, more or less according to circumstances.

To see if there is any significant difference in the rate of profit earned by different types of work organization, we conducted a one-way rank analysis of variance of the rates of profit earned by fishing teams falling within different types of work organization by calculating the Kruskal-Wallis *H*-statistic[2] (Kruskal and Wallis 1952). The *H*-statistics for seasons I and II were 2.736 and 0.366 (both are not significant even at the 10% level). Therefore, the rates of profits (Table 5) are not significantly different for the three types of work organization. The rate of profit (equation 5) has been defined in Marxian terms as the surplus value divided by the cost of producing it. Thus it corresponds to a fishing-team leader's own notions of profit rate, that is net revenue divided by the cost of production.

The issue of why the rates of profit for different work organizations delineated by the "labour-exploitation" ratio do not vary significantly can be examined at two levels: the technoeconomic level and the production-relations level.

In the case of the River Jamuna fishery, the technology used is very traditional. The organic composition of capital (or capital intensity) is more or less similar for all three work organizations as reflected in their approximately equal ratios of boat capacity to labour employment (0.055-0.078). What really differs among them is the scale of operation. Under the circumstances of such similar capital intensity, the surplus value generated may differ in volume, but not much as a proportion of variable capital. Therefore, under the prevailing technology, the rates of profit earned by the three groups are not likely to differ significantly.

In calculating the rate of profit, we have used monetary quantities because these are of prime interest to the profit-seeking entrepreneur. The external crust of monetary values conceals the production relations, i.e., the relationship between man and his objects of labour and the relationship between man and man. To remove this outer crust, which exhibits the evenness in the rate of profit earned, we undertake another exercise that exposes uneven and complex relations pervading through the classes.

Fishing in the River Jamuna has two spheres: that of production and that of circulation. The nature of relations within and between these two spheres has differing predicament and propitiation on the rate of profit earned by the fishing-team leaders. Rowthorn (1974) has presented a relation matrix for these two spheres under different modes of production. This relation matrix has contextual relevance to our subject matter and is shown in Table 6 (the fishing enterprise on the River Jamuna is similar to the enterprise described as "merchant capital plus simple commodity production"). However, we can add another agent with merchant capital, that is, the lessee capital, to make this modular form more akin to the reality of the River Jamuna fisheries. At the same time, the concept of simple commodity production is more diluted as we approach strata with higher labour-exploitation ratios, because they are not a

[2]The *H*-statistic for the Kruskal-Wallis test is defined as:

$$H = \{12/[n(n+1)]\} \{\sum_{j=1}^{k} (R_j^2/n_j)\} - 3(n-1)$$

Where k is number of independent samples (or identical populations); n_j is number of sample observations from the jth population; R_j is sum of ranks in the sample from the jth population (ranks are assigned by grouping all sample observations); and n is total number of observations from the k samples. When each sample has five or more observations, the *H*-statistic approximates a χ^2 distribution with (k - 1) degrees of freedom. Note that this is a one-tail test of the null hypothesis, which is rejected by large values of *H*. Also note that it is (k - 1), not (n - 1), that determines the degrees of freedom for using the χ^2 distribution to obtain a critical value of *H* for the decision rule.

Table 5. Average profit rates of three economic classes of fishing teams in the River Jamuna, Bangladesh, 1980–81.

Class	Mean	Minimum	Maximum	Standard deviation	Number
Protocapitalist	0.236	−0.675	1.266	0.3775	22
Upper artisanal[a]	0.502	−0.196	1.359	0.5133	12
Lower artisanal	0.406	−0.608	1.432	0.5833	17

[a]One observation in the upper artisanal class was clearly unrepresentative of the class and has been omitted. If it were included, the average would be 1.298, minimum, −0.196, maximum, 9.359, standard deviation, 2.4753, and number of observations, 13.

Table 6. Rowthorn's relation matrix.

Sphere	Merchant capital plus simple commodity production	Simple commodity production	Capitalist production
Circulation	Unfreedom and inequality	Freedom and equality	Freedom and equality
Production	Freedom and equality	Freedom and equality	Unfreedom and inequality

Source: Rowthorn (1974).

Table 7. Correlation[a] between price, profit, rent, and wage variables by economic class in River Jamuna fishery, Bangladesh, 1980–81.

Economic class	Price	Profit rate	VMP minus wage[b]	Wage deductions due to wage advance
Protocapitalist				
Price	1.000	–	–	–
Profit rate	−0.405**	1.000	0.504**	−0.011
Rent	0.407**	−0.619*	−0.134	0.168
Upper artisanal				
Price	1.000	–	–	–
Profit rate	0.138	1.000	0.348	−0.062
Rent	−0.400***	−0.242	0.404	0.594**
Lower artisanal				
Price	1.000	–	–	–
Profit rate	0.603**	1.000	0.660**	0.071
Rent	−0.375**	−0.050	0.535**	0.414***

[a]Asterisks indicate significance at 1% (***), 5% (**), or 10% (*) levels.
[b]Difference between value of the marginal product of labour (VMP) and wages.

"Chayanovian category" of independent producers. The labour process in the groups with higher labour-exploitation ratios retains elements of freedom and equality characteristic of simple commodity production insofar as labour remuneration is a traditionally fixed proportion of the value created, but it also assumes an unfree and unequal relation through the wage-advance system. Historically, in a "merchant capital plus simple commodity production" configuration (Rowthorn 1974):

> The monopoly of the intermediaries deny to the individual producers the right, or at least the opportunity, of trading with anyone else. . . . The intermediary is in a privileged position as a trader.

The correlation coefficients of Table 7 show the differential impact of involuntary or forced commerce on the three economic classes. If a situation arises in which the fishing teams are left no option other than selling the catch to the lessee who is a fish merchant as well, a bargain is reached between the parties. Here, the exchange between the lessee and the fishermen is of a contrived nature. The lessee agrees on a higher price per unit of catch only when the fishing team agrees to pay a higher proportion of the gross value of the catch as rent. Under such bargains, the lessee has the upper hand. The protocapitalist class of fishing-team leaders have been observed to be trapped in the nexus of such forced commerce — the *jalmahals* chosen by this group are far away from the fish distribution points. As a result, fishing rights and the disposal of catch become interlocked as is apparent from the correlation matrix of Table 7.

Relaxation of this interlocking arrangement for the other two groups has produced tendencies in the opposite direction, especially for the lower artisanal group. The latter, owning smaller fishing equipment, carry out their fishing activities in a segment of the river adjacent to their own villages and catch small volumes of fish per day, which can be easily carried as a head-load to the nearest *Nakalia Bazar*. Thus, they can take advantage of the retail price and, therefore, the rate of profit earned by them is positively and highly correlated with the price of fish per unit.

Price and profit rate correlation coefficients improve from a high negative for the protocapitalist class to high positive for the lower artisanal class (Table 7). This is because, when a group of competitive sellers is faced with inelastic demand for their product, they find that the more they sell, the lower are their receipts. This is the normal situation for primary and highly perishable products such as fish. Even when the demand for the final product sold to the consumers is highly elastic, the demand for the primary product is unlikely to have an elasticity greater than unity, because the final price contains the dealers' profits at various stages, transport and packaging charges, and the retail margin of the final seller. The important feature of this situation is that it arises out of the very fact that producers are specialized. Fishermen, being producers of this nature, have no means of shifting to something else. Thus, they are at the mercy of the market. In our case, the fishermen are constrained to sell instantaneously more and more of their net catch as we pass on to higher labour-exploitation strata. The lower artisanal class, with retail market advantage, seems to be best off in this respect.

Further, the rent paid (as a proportion of the value of output) is negatively related to the rate of profit earned (Table 7). However, this association weakens from the higher to lower labour-exploitation ratio stratum; indeed, it is only marginally statistically significant for the protocapitalists. Wage deductions for wage advances are also associated differentially with the rents paid by the three classes: the correlation coefficient for the protocapitalist group is low, positive, and nonsignificant whereas those for the upper and lower artisanal groups are high, positive, and significant. Because interlocking arrangements between fishing rights and product disposal are minimal for these two classes, it makes their wage cut calculations easier and the correlation stronger. For the protocapitalist class, however, the contrived nature of the market for the product makes the calculations difficult and the correlation weak.

As far as the labour-use relations are concerned, all the classes have high positive correlations between the rate of profit earned and the extent to which the wage rate falls short of the value of the marginal product (VMP) of labour. The difference in the degree of association is explained by the differential leader–labour dependence for employment among classes and the propensity for self-exploitation by self-employed labour. There also appears to be a significant positive association between rent paid and the difference between VMP and wages for the lower artisanal class (Table 7).

We may, thus, conclude that the differential action of advantages and disadvantages across different relations tends to even out the effect on the net surplus value earned by the three classes. In a transitional society like Bangladesh, social "classes" do not exist in their pure form. Therefore, even among fishing-team leaders, the interaction of multiple and complex relations may produce a situation of equal rates of profit earned, although their absolute level of profit differs.

Summary of Findings and Policy Recommendations

Fishing in the River Jamuna is a traditional artisanal activity. Property rights over the fishing segments of the river are determined by governmental regulation and there are contractual arrangements among all the parties — government, lessees, fishing-team leaders, and the fishing-team labourers. Transaction and policing costs are also such that fishing on the River Jamuna is not open-access. Therefore, the prevailing socioeconomic conditions do not pose a problem of overexploitation: an observation that is supported by empirical evidence on fishing-rents. However, it cannot be concluded that fish resources are managed at the socially optimum level.

Fishing-team leaders can be stratified into three well defined classes — the protocapitalists, the upper artisanal, and the lower artisanal — on the basis of relations of production using Patnaik's *E*-criterion or "labour-exploitation" ratio. Production function analysis indicates that productivity tends to be lower for the upper *E* classes (i.e., those classes with higher outside-labour exploitation ratio). The rates of profit earned by the different *E*-criterion classes do not differ significantly. Technoeconomic factors, the complex nature of intertwined relations, and varying degrees of freedom and unfreedom in exchange relations tend to even out the effect on the rate of profit earned.

Policy measures based on these findings and formulated with a view to improving the existing state of affairs in riverine fishing include:

- Augmenting the stock of fishery resources so as to enhance the future availability of fish for consumption; and
- Ensuring more equitable return to the parties involved and to any potential entrants.

Bangladesh does not have any reliable estimates of its riverine fish stock, the reproductive behaviour of the various species of fish, or the carrying capacity of the rivers in terms of fish biomass. This is an area where biological scientists can make a contribution. Once these estimates are available, social scientists can determine the level of maximum sustainable social benefit.

Because the present system of administering property rights does not appear to incorporate risks of overexploitation, the existing arrangement can be allowed to continue with some slight corrective measures. The contract between the government and the lessees should also incorporate any conditions that must be passed on by the lessees to the fishermen. These conditions can be achieved without much additional cost to the lessees as this cost can very well be incorporated within their policing system.

The trend toward entry into riverine fishing by the marginal groups can be checked through generating additional and greater income-yielding opportunities in the rural areas. Perhaps the larger issue of widely advocated reform measures can be linked with this measure. Traditionally low-caste Hindu fishermen could be slowly withdrawn from fishing by extending educational opportunities to them and education-subsidy schemes may be worthwhile. There is evidence that education helps them leave their age-old occupation.

The problem of forced commerce and the contrived nature of market can be minimized by extending the area of action of the state-sponsored Fisheries Development Corporation. This corporation could initiate a scheme for small-scale fish-preservation centres in major fish-landing points. If fishermen could preserve their catch in those centres, their bargaining strength with the fish merchants would increase at the cost of a small fee for the service.

The supernormal rent earned by the lessees could, and should, be subjected to effective income taxes.

Eligibility for institutional credit should be extended to include fishing labour. Lessons can be drawn in this regard from the *Grameen Bank Prakalpa* (Rural Banking Project) sponsored by the Central Bank of Bangladesh.

Ecological changes should certainly be watched and ameliorative measures should be studied and gradually implemented. At the same time, Bangladesh should gradually shift toward culture fisheries from capture fisheries in the riverine sector. Culture practices have yielded good results in the riverine sector in neighbouring India.

Local communities have proved to be successful in local-level rural-development projects in some areas of Bangladesh and small-scale action-research projects should be undertaken to see if local communities can be involved in the management of fisheries. This will include institutional alternatives to the existing leasing system.

Appendix: The Sharing System

This is a brief example of the procedure used to calculate the distribution of the net value of output among the various members of the fishing team — the boat owner, net owner, and labour.

The sample fishing team has the following characteristics:

- 40 members;
- 10 nets; and
- Three boats with lengths of 10.1, 9.6, and 6.9 m.

The team catches fish worth 1 500 000 BDT but pays out 40 000 BDT in rent and 25 000 BDT for other expenses during the fishing operation.

The following share structure has been set up:

- Each member, 0.5;
- Each net, 0.5; and
- Boats, 1.0 shares each for the 10.1- and 9.6-m boats and 0.75 for the 6.9-m boat.

This gives a total of 27.75 shares comprised of 20.0 for members (40.0 × 0.5), 5.0 for nets (10 × 0.5), and 2.75 for boats (1.0 + 1.0 + 0.75). The net value of output accruing to the team, 85 000 BDT (1 500 000 - 40 000 - 25 000), must be shared among the total shares of boats, nets, and members. Therefore, each 1.0 share receives 85 000/27.75 or 3063.06 BDT. A member who owns one net would receive a full share (0.5 for his labour and 0.5 for his net) of 3063.06 BDT but a member without a net would receive only half of this or 1531.53 BDT.

Review of Government Programs

Impact of Credit on Small-Scale Fisheries in the Philippines

Aida R. Librero and Rebecca Catalla[1]

Credit has always been an integral component of the overall scheme to accelerate rural development in the Philippines. For the 5-year period 1975–79, over 7030 million PHP (in 1979, 7.40 pesos [PHP] = US$1) had been channeled to the fisheries sector. Although the amount is small compared with the total loans granted to the agricultural sector, loans granted to fisheries have grown tremendously in recent years: fisheries loans granted in 1979 were 4.5 times their 1975 level.

Of the three sectors of the fishery industry, credit allocation has historically been in favour of the large-scale fishery and aquagculture projects because of their greater "bankability," as compared to the municipal fishery — small-scale or municipal fishermen are those operating boats of less than 3 gross tons (GT). At the same time, the municipal fishery involves higher risks and administrative costs yet the fishermen have few assets to offer as collateral and so could not qualify to borrow from commercial banking institutions. A massive financing program was therefore initiated by the Development Bank of the Philippines (DBP) to help fishermen obtain credit without collateral. Loans to a maximum of 5000 PHP/borrower were extended to enable fishermen to acquire motorized boats and catching gear. Meanwhile, other lending institutions such as the Philippine National Bank (PNB) and the Agricultural Credit Administration (ACA), as well as the rural banking system (consisting of rural banks around the country), had likewise granted loans to subsistence fishermen.

Because more than 5 years have elapsed since the initiation of the program, its impact on the fishermen needs to be assessed. The assessment will guide policymakers and program planners in evaluating the program and in determining modifications that are needed in implementing current programs. The analysis will also help in planning related programs for small-scale producers.

The present study, therefore, is intended to determine the extent to which these financing programs have been effective in bringing about technological and socioeconomic changes among the small-scale fishermen and is based on a nation-wide socioeconomic survey in 1979. More specifically, the objectives of the study are:

- To determine the availability of credit information, awareness of credit programs, and the extent and manner of credit utilization;
- To examine the credit packages in relation to the actual requirements of fishing;
- To assess the effectiveness of the government's credit program in changing levels of technology; and
- To analyze the impact of credit on production, income, and general welfare.

Conceptual Framework and Methodology

Increasing credit is one of the policy instruments considered to facilitate technology transfer, stimulate productivity, generate employment, and increase income. Credit provides additional capital to the fishermen to enable them to purchase necessary equipment and inputs for their production. Studies on agricul-

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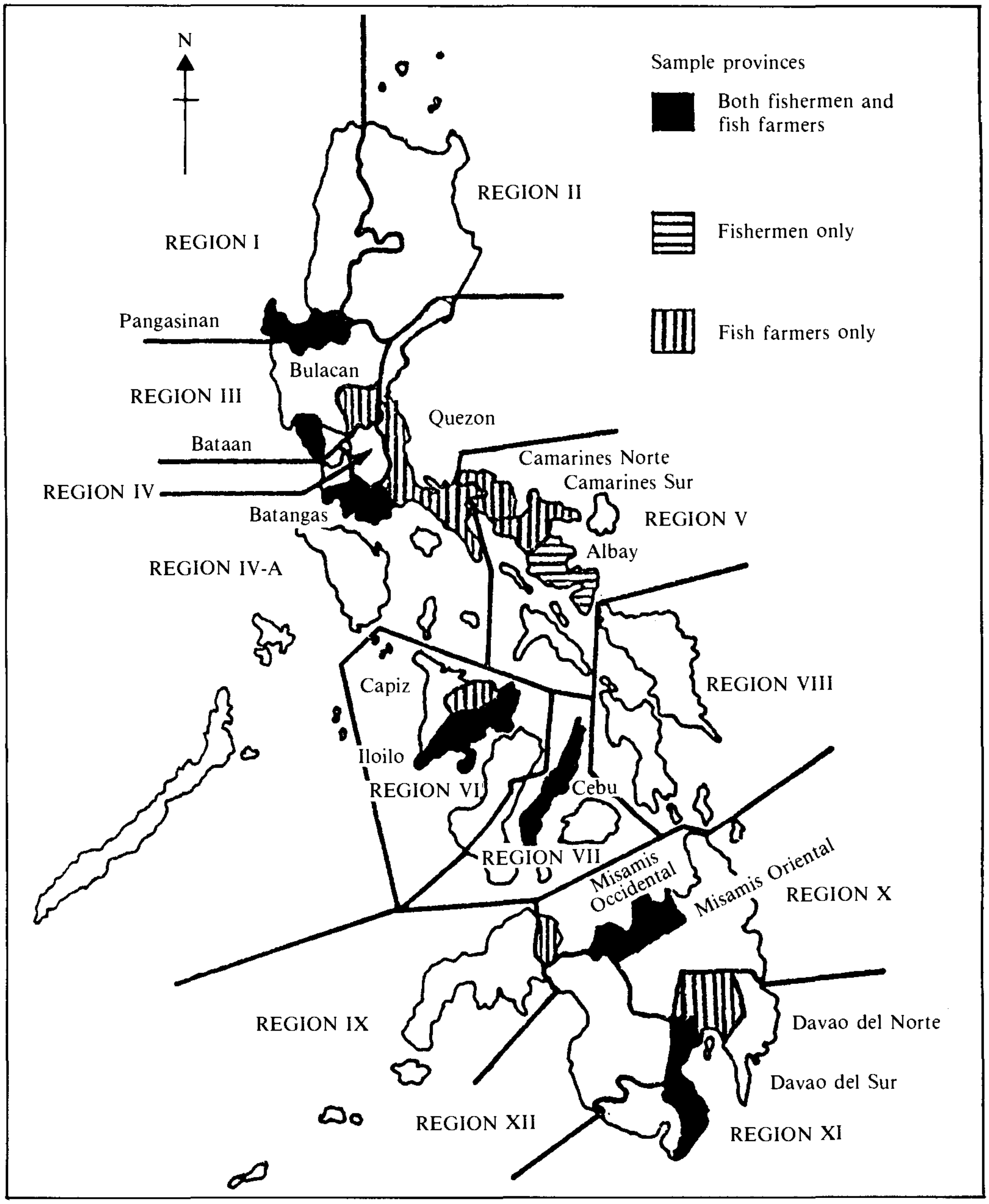

Fig. 1. The Philippines by administrative region showing the sample provinces for fishermen and fish farmers. (Regions I, II, III, IV-A, and V constitute Luzon; Regions VI, VII, and VIII, Visayas; and Regions IX, X, XI, and XII, Mindanao.)

ture have shown that credit accelerates the adoption of improved farm practices resulting in increased production and income. It is in this context that the impact of credit on fisheries will be analyzed.

Credit is being provided to fishermen specifically to enable them to purchase boats, motors, and catching gear and to pay for major operational expenses and thus is being used as a tool to promote more rapid adoption of technology in municipal fisheries. It is assumed that such adoption will increase the catch and eventually the income of fishermen. However, such an assumption should take into account the "fixity" and the open-access status of fishery resources. More entrants into an industry with "fixed" resources may not increase total catch and will certainly lower the catch per unit of effort.

The DBP started its small-scale fisheries credit scheme in 1974. Because of the long period that has elapsed between 1974 and the survey (1979), it would be difficult for the fishermen-respondents to recall data on fishing operations and on socioeconomic conditions before the loan was borrowed. Thus, a comparison of borrowers and nonborrowers from the same geographic location was made while simultaneously attempting to get quantitative and qualitative information on changes that occurred between 1974 and 1979.

From DBP's list of fishermen-borrowers throughout the country, eight provinces from eight regions with the largest number of borrowers were chosen (Fig. 1). From each sample province, two municipalities were selected based on the largest number of DBP borrowers and, within each sample municipality, two fishing villages were chosen. In each sample village, eight fishermen-borrowers were randomly drawn from the list of DBP borrowers and another eight fishermen were selected from among those who did not borrow from DBP.

The survey was conducted from April to June 1979. A total of 506 fishermen were interviewed, 286 of whom acquired loans from DBP, other financing institutions, private persons, or from a combination of these sources. To measure the impact of credit, borrowers and nonborrowers were compared in terms of their fishing technology, production, income, living conditions, and other indicators of standard of living.

Awareness of Credit Institutions, Extent of Credit, and Credit Utilization

Generally, fishermen were aware of the various lending institutions that cater to the financing or credit requirements of those engaged in fisheries. Among the best known were DBP, the rural banks, and other financing institutions such as ACA, the development and savings banks, and credit unions.

With the sizeable amount of loans it has granted, DBP ranked first among the lending institutions: 87% of the borrowers claimed that they secured loans from DBP whereas only 24% resorted to private lenders, specifically the fish brokers and dealers. However, the latter group includes fishermen borrowing from two or more sources.

Although DBP granted a maximum amount of 5000 PHP, on the average, only about 80% of this amount was taken up by municipal fishermen (Table 1). On the average, fishermen of Northern Mindanao borrowed the largest amount from DBP and those of Central Luzon the lowest. The largest amount borrowed from other financing institutions was in Southern Mindanao and the smallest in Northern Mindanao, secured largely from fish brokers and dealers. Private sources made loans ranging from an average of 358 PHP in Northern Mindanao to 5104 PHP in Western Visayas — the former having been acquired from neighbours or friends and the latter from fish brokers or dealers.

Loans acquired were used for the purchase of fishing boats, engines, and catching gear and financing other fishing-related expenditures (Table 2). The amount borrowed was spent mainly on engines, 56% of the loan, or boats, 28% of the loan.

Table 1. Average amount of credit borrowed by sample fishermen by source and by region, Philippines, 1975–79.

		Amount borrowed (PHP)[a]			
Region	Number of borrowers	Development Bank of the Philippines	Other financing institutions	Private persons	All sources
Ilocos	32	3688	0	0	3688
Central Luzon	47	3303	2000	1762	3352
Southern Tagalog	40	4338	0	2762	4022
Bicol	31	4194	0	0	4194
Western Visayas	35	3641	900	5104	4401
Central Visayas	35	4156	200	1025	3864
Northern Mindanao	33	4373	175	358	3886
Southern Mindanao	33	3950	4000	1039	3991
All regions	286	3949	1635	2195	3900

[a]In 1979, 7.40 pesos (PHP) = US$1.

Table 2. Loan utilization by region, Philippines, 1975-79.

Region	Number of borrowers	Amount borrowed (PHP)[c]	Purchase of — Boat PHP	%	Engine PHP	%	Catching gear PHP	%	Other[a] fishing use PHP	%	Non-fishing use[b] PHP	%	Unaccounted PHP	%
Ilocos	32	3688	983	27	2505	68	200	5	0	–	0	–	0	–
Central Luzon	47	3352	562	17	2044	61	437	13	184	5	125	4	0	–
Southern Tagalog	40	4022	1552	38	2138	53	186	5	28	1	22	<1	96	2
Bicol	31	4194	1173	28	2257	54	417	10	74	2	0	–	273	6
Western Visayas	35	4401	1310	30	2448	55	512	12	122	3	9	<1	0	–
Central Visayas	35	3864	1062	28	2123	55	505	13	15	<1	83	2	76	2
Northern Mindanao	33	3886	1173	30	1883	48	342	9	123	3	335	9	30	1
Southern Mindanao	33	3991	1067	27	2042	51	84	2	161	4	538	14	99	2
All regions	286	3900	1095	28	2172	56	338	9	92	2	136	3	67	2

[a]Includes repair of gear, engine, and boat and operating expenses.
[b]Includes expenses in following-up loan, agent's fee, food and clothing, children's education, social expenses, house repair, medical expenses, coast guard fee, and capital for business.
[c]In 1979, 7.40 pesos (PHP) = US$1.

Fishery Credit Package and Credit Needs

A fisherman's demand for credit may be defined as the amount of loan that he will borrow at different prices, that is, at different costs or interest rates, given his level of income and preferences. Although demand for credit can be estimated statistically from cross-sectional data, only a crude estimate of credit "requirements" was made here. Fishermen were asked directly of their perception of the amount needed, the actual amount they had borrowed in the past, and whether their present loans were sufficient.

The amount made available by the various lending institutions to fishermen (3900 PHP/fisherman) was reported to be only 55% of the estimated requirement (7100 PHP). Although more than 50% of the fishermen felt that they still needed loans, it is noteworthy that almost 50% reported no need for credit.

If it were available, 53% of the fishermen who said they needed credit would take out a loan. Apparently, their demand for loans stemmed from the need to purchase new gear and a new motorized boat as well as for the repair of a boat or gear, or both. The rest reported that, although they needed loans, they were not willing to actually borrow the required amounts because of difficulties in payment of loan amortization and the unpaid balance of their first loan.

Of the fishermen who acquired loans, 75% admitted to having encountered some difficulties in borrowing and the amount borrowed was found insufficient by 46% of them. Other problems reported were delayed release of loan, high interest paid, high controlled prices for motors and engines, and the like. As an immediate effect of these problems in loan acquisition, 54% of the fishermen borrowers stated that they would not borrow anymore. However, the other 46% stated that such difficulties had no effect on their future plans for borrowing.

Of the fishermen-borrowers, 45% had suggestions to improve the credit program for the fishing industry. These included an increase in the amount of loan, lump-sum release of loan, loans should be extended without interest, loans should be repaid, and DBP collectors should visit the fishermen's community more frequently.

Repayment

One of the setbacks in the fisheries credit program is the prevailing low rate of repayment and, among the fishermen-borrowers studied, repayment rates were very low. Among those who acquired loans from the DBP, only 1% had paid their loans in full, 64% had made partial payments, and the others, 35%, had not paid any amount at all. In contrast, those who borrowed from private persons showed a repayment rate of 80%, with partial payments having been made by 13%, and only 7% having made no repayment. Those who borrowed from "other financing institutions" had all paid their loans in full.

The fishermen who obtained credit from two sources presented the same pattern. If the DBP had been one of the sources, the DBP loans had either been paid only partially or not at all. These borrowers tended to pay their obligations more to the other financing institutions or to private persons rather than to DBP. These relatively higher repayment rates for lending institutions other than DBP may probably be attributed to greater social pressures exerted on individuals borrowing from private sources. Moreover, the relative inaccessibility of DBP itself had contributed to nonrepayment.

The partial payment or nonrepayment of loans may be traced to a number of factors. More than 75% of the fishermen gave a poor catch as a major reason, brought about by the increased fishing population and, consequently, stiff competition on the fishing grounds. Other demands for cash, such as medical expenses, children's education, and the like, had also dissipated the capacity to repay. About 10% of the fishermen studied considered their loans as aid from the government and, therefore, did not feel compelled to make any repayment. In addition, 9% considered the high cost of living as a contributory factor for their nonrepayment. Three fishermen intentionally did not repay because others had not done so.

Impact of Credit

On fishing assets and technology

The performance of the credit program can be evaluated in terms of its effects on fishing assets and technology, on catch and incomes, and on the general socioeconomic conditions of the borrowers attributable to the program.

The impact of credit was reflected in the day-to-day fishing activities of the fishermen. About 76% indicated that their loans had provided them with motorized boats that have been useful when fishing in remote places or when looking for better fishing grounds. Some 20% reported that credit provided them with better fishing gear and 11% said that they were able to buy their necessary fishing equipment. Other ways in which credit had been used were for acquisition of higher-powered engines; for purchase of fishing equipment; for purchase of gasoline and other operating expenses; for repair of gear and boat; as capital for business; and for emergency needs.

Because most of the borrowers were able to purchase motorized boats, the distance traveled increased compared to previous years (before 1974). Although earlier they had been going only as far as 24 km, at time of the survey, they were going 6 km farther out. In contrast, the distance traveled by nonborrowers increased by just a little over 1 km/trip between 1974 and the time of the survey. The number of fishing days per week, however, was practically the same for both borrowers and nonborrowers.

One of the direct effects of the credit program on small-scale fishermen was in the acquisition of boats and other fishing assets. Before credit was freely available, only 63% of the borrowers were boat owners (Table 3) but, by 1979, 91% of borrowers owned a boat, reducing the proportion of boat renters from 4 to 2% and of shareworkers from 25 to 7%. (It should be noted that the change was based only on the sample of fishermen studied; with the rise in boat ownership, a general increase in shareworkers could have occurred simultaneously if the fishing population increased.) The increase in boat ownership among the nonborrowers was not as spectacular. The proportion of shareworkers was somewhat reduced and that of boat renters increased only slightly.

By source of credit, fishermen who borrowed from DBP were found to have the highest increase in the number of boat owners, from 64 to 93%. Similarly, many of those who borrowed from two sources became boat owners, thus reducing the number of shareworkers and converting boat renters into boat owners. In contrast, the percentage of boat owners had not changed among borrowers from private sources but the percentage of boat renters had increased. Apparently, loans from private individuals are not used to purchase boats.

The effect of credit was reflected not only in an increased percentage of boat owners but also in an increased number of boats per fisherman. In 1974, or before loan acquisition, few fishermen owned more than one boat. With credit being available, more of the fishermen, particularly the borrowers, acquired more than one boat and, in 1979, fishermen-borrowers owned a higher average number of boats than nonborrowers (0.96 vs 0.66, Table 4).

Table 3. Distribution (%) of fishermen in three classes related to boat ownership before and after credit became available, by source of credit, Philippines, 1974 and 1979.

	Boat owners		Boat renters		Share-workers	
Source	1974	1979	1974	1979	1974	1979
Borrowers	**63**	**91**	**4**	**2**	**25**	**7**
DBP[a]	64	93	4	2	23	5
DBP and others	34	79	8	0	54	21
Private persons	77	77	3	10	20	13
Others	67	83	0	0	33	17
Nonborrowers	**56**	**67**	**10**	**11**	**27**	**22**
All fishermen	**58**	**75**	**7**	**7**	**30**	**18**

[a]Development Bank of the Philippines.

Table 4. Type of boat owned by borrower and nonborrower fishermen, by region, Philippines, 1974 and 1979.

Location	Number of respondents	Number of boats owned[a]		Motorized (%)		Nonmotorized (%)	
		1974	1979	1974	1979	1974	1979
Ilocos							
Borrowers	32	21	24	0	83	100	17
Nonborrowers	32	15	17	0	6	100	94
Central Luzon							
Borrowers	47	27	36	67	97	33	3
Nonborrowers	17	7	10	43	70	57	30
Southern Tagalog							
Borrowers	40	28	42	93	100	7	0
Nonborrowers	24	9	13	78	69	22	31
Bicol							
Borrowers	31	28	31	25	94	75	6
Nonborrowers	32	23	23	43	48	57	52
Western Visayas							
Borrowers	35	5	39	100	100	0	0
Nonborrowers	29	15	26	73	81	27	19
Central Visayas							
Borrowers	35	18	36	50	100	50	0
Nonborrowers	29	14	19	43	47	57	53
Northern Mindanao							
Borrowers	33	25	32	12	88	88	12
Nonborrowers	28	11	12	55	75	45	25
Southern Mindanao							
Borrowers	33	22	36	23	75	77	25
Nonborrowers	29	19	26	32	46	68	54
All regions							
Borrowers	286	174	276	42	93	58	7
Nonborrowers	220	113	146	43	54	57	46

[a]Excluding rafts.

The increased proportion of fishermen reporting boat ownership suggests, to a certain degree, the impact that loan availability has had on a fisherman's fishing assets. Specifically, the type of boat used, its length and tonnage, and the power of engines as well as the number and type of catching gear were most affected by acquisition of loans.

Those who owned motorized boats increased from a proportion of 42 to 93% of the fishermen among borrowers and from 43 to 54% among nonborrowers (Table 4). The change among borrowers was remarkably higher than that of nonborrowers.

The change in percentage of boats with motors was most dramatic among those who used credit in Ilocos where none of the boats were motorized in 1974 and 83% were motorized in 1979. In Northern Mindanao, the change was almost as dramatic, from 12% to 88%. Among the boats owned by the borrowers in the other regions, the percentage change was similarly high, except in Western Visayas and Southern Tagalog where all or most of the boats owned by borrowers were motorized before loans became available.

With the increased motorization of boats, some borrowers and nonborrowers in several regions had been able to acquire more than one engine. Although, on the average, nonborrowers owned more engines (1.02) in the past, the borrowers now own more (1.07).

There has also been a differential increase in the horsepower of engines since 1974, although this has been slight. The proportion of borrowers owning engines with over 15 horsepower (HP) increased from 25 to 50% whereas the change among nonborrowers has been from 26 to 47%. This differential may be traced to the fact that most of the motors that were given in kind by DBP had a power output of 16 HP.

Not only did engines become more powerful but also the size of boats increased both in terms of length and tonnage. Again this increase was more significant among borrowers, the great majority of whom have acquired boats of 6–10 m in length and 0.50–1.50 GT, than nonborrowers, most of whom were still using boats shorter than 6 m and lighter than 0.50 GT.

Table 5. Number and type of catching gear items owned by borrower and nonborrower fishermen, Philippines, 1974 and 1979.

	Borrowers		Nonborrowers		All fishermen	
	1974	1979	1974	1979	1974	1979
Number reporting	182	261	129	168	311	429
Number of items of gear owned	208	316	143	195	351	511
Number of items per fisherman	1.14	1.21	1.11	1.16	1.13	1.19
Number of items of gear owned (%)[a]						
One item	87	82	90	86	89	84
Two items	11	14	8	11	10	13
Three items	2	4	2	3	1	3
Type of gear owned (%)[b]						
Longline	37	23	36	35	33	23
Handline	19	16	18	15	17	14
Gill net	35	45	36	39	32	36
Lift net	4	3	6	7	4	4
Seine net	5	7	2	2	3	4
Baby trawl	5	13	2	3	4	8
Other nets[c]	3	7	2	5	3	6
Hand instruments	4	3	3	5	3	4
Barriers and traps	1	1	2	2	1	1

[a]Percentage distribution of fishermen owning the corresponding number of gear items.
[b]Percentage distribution of fishermen owning the corresponding type of gear. Percentages total more than 100 because some fishermen owned more than one type of gear.
[c]Includes bag net, scissors net, *salap*, and scoop net.

The number of fishing gear per fisherman, as well as the type of fishing gear, changed considerably between 1974 and 1979 but these changes can hardly be attributed to the credit program because they occurred both among borrowers and nonborrowers to approximately the same degree (Table 5). There has been some substitution of gill nets and impounding nets (lift nets, seine nets, baby trawls, etc.) for longlines and handlines.

On capital investment

Generally, the fishing equipment (i.e., boat and engines) and the catching gear are the major items that comprise a fisherman's capital investment. Additional investment is made on lamps, containers, painting equipment, and materials for constructing fishing gear.

On the average, borrowers invested more on their fishing equipment than the nonborrowers (2591 vs 1148 PHP, Table 6). The highest outlay expended among the major items of investment was on engines, 1185 PHP for borrowers and 438 PHP for nonborrowers. This was followed by the amount invested in catching gear, 672 PHP for borrowers and 361 PHP for nonborrowers.

By regions, the borrowers of Southern Tagalog had an outlay close to 2000 PHP for engines alone. For catching gear, the borrowers of Western Visayas had paid as much as 1505 PHP because fishing there entailed the use of gill nets. Most nonborrowers at Ilocos, on the other hand, used hook and line, handlines, or longlines, and therefore spent only 78 PHP, the lowest of any group or region.

Of the other items of investment, lamps required a considerable outlay particularly among the fishermen of Bicol and Northern and Southern Mindanao, who employed several units of pressure lamps, which were more expensive than the ordinary kerosene lamps used by fishermen in other locations. Again the borrowers had more invested in lamps.

As expected, fishermen who had been assisted by the credit program were able to invest more than the fishermen who had received no credit assistance. In all regions, those who obtained loans invested almost twice as much (and sometimes more) in fishing equipment than those who did not borrow.

On the catch

Production, the weight of fish caught, of borrowers and nonborrowers alike declined (Table 7). In 1974, borrowers caught 2725 kg of fish and nonborrowers, 3062 kg but, in 1978–79, they both caught only about 2250 kg/year. Thus the decline in catch was larger (25%) for nonborrowers than for borrowers (18%).

By region, the drop in catch was largest among borrowers of Western Visayas where

Table 6. Average capital investment (PHP)[a] of borrower and nonborrower fishermen by region, Philippines, 1978–79.

	Boat	Motor	Catching gear	Lamps	Other	Total
Ilocos						
Borrowers	233	602	141	0	11	987
Nonborrowers	40	18	78	0	7	143
Central Luzon						
Borrowers	452	1058	598	6	33	2147
Nonborrowers	224	476	584	1	5	1290
Southern Tagalog						
Borrowers	1205	1853	818	84	12	3972
Nonborrowers	539	603	664	36	12	1854
Bicol						
Borrowers	654	1453	582	340	21	3050
Nonborrowers	401	468	363	144	5	1381
Western Visayas						
Borrowers	584	1191	1505	14	10	3304
Nonborrowers	483	916	767	10	34	2210
Central Visayas						
Borrowers	660	1422	472	7	4	2565
Nonborrowers	164	327	88	4	<1	583
Northern Mindanao						
Borrowers	637	1052	724	150	18	2581
Nonborrowers	119	424	273	41	4	861
Southern Mindanao						
Borrowers	528	821	568	182	61	2160
Nonborrowers	412	356	244	96	4	1112
All regions						
Borrowers	622	1185	672	90	22	2591
Nonborrowers	295	438	361	44	10	1148

[a]In 1979, 7.40 pesos (PHP) = US$1.

average production went as low as 1972 kg from a previous level of 3947 kg. In contrast, a high, almost unchanged, production of 4747 kg was observed among the nonborrowers of Central Luzon. The lowest volume of catch on the other hand was observed among nonborrowers in Ilocos where it dropped by 29% from 1018 kg down to 718 kg. However, borrowers experienced an increase in catch in Bicol (20%), Central Visayas (7%), Northern Mindanao (37%), and Southern Mindanao (27%) whereas nonborrowers only had an increase in Northern Mindanao (29%).

Several reasons were cited by the fishermen for the change in the volume of the catch. Of the 80% of borrowers and 92% of nonborrowers who stated that their catch had declined, 50 and 62% respectively attributed their low catch to the increased number of fishermen. Some 38% of the borrowers and 31% of the nonborrowers ascribed it to fish scarcity and 10% of the former and 4% of the latter mentioned the presence of trawlers as one factor for their low catch. Other factors that were said to have caused low production were pollution, less time spent in fishing, inappropriate gear, and change in fishing grounds. Of course, all these factors are related but are listed separately to indicate the perception of the fishermen regarding changes in the volume of catch.

Among those who had experienced an increase in production, 46% of the borrowers but only 25% of the nonborrowers attributed their increased catch to gear improvement. The improvement in the gear included, among other things, the transition from hooks and lines, handlines, and longlines to gill nets; from handlines to beach seines; and from spears, longlines, and handlines to baby trawls and gill nets.

The motorization of boats must also have contributed to the increased catch. To some extent, the change in catching gear used was a direct effect of the type of boat used.

A factor that also must have contributed to increased output by some of the borrowers and nonborrowers was the fact that they were able to explore and exploit more fishing grounds — as noted earlier, because of their motorized boats, fishermen had been able to venture farther than they did in the past.

Table 7. Average volume of fish caught by borrower and nonborrower fishermen, by region, Philippines, 1974 and 1978–79.

Location	1974		1978–79		% change 1974 to 1978–79
	Number reporting	Annual catch (kg/fisherman)	Number reporting	Annual catch (kg/fisherman)	
Ilocos					
Borrowers	32	1617	32	943	-42
Nonborrowers	32	1018	32	718	-29
Central Luzon					
Borrowers	47	4592	47	3747	-18
Nonborrowers	16	4884	17	4747	- 3
Southern Tagalog					
Borrowers	38	2747	40	2169	-21
Nonborrowers	23	3224	24	2278	-29
Bicol					
Borrowers	31	2575	31	3092	20
Nonborrowers	32	6046	32	4304	-29
Western Visayas					
Borrowers	26	3947	35	1972	-50
Nonborrowers	27	5469	29	3401	-38
Central Visayas					
Borrowers	32	1918	35	2055	7
Nonborrowers	22	1248	29	1002	-20
Northern Mindanao					
Borrowers	30	786	33	1077	37
Nonborrowers	26	1301	28	1676	29
Southern Mindanao					
Borrowers	27	1850	31	2350	27
Nonborrowers	25	1270	28	1107	-13
All regions					
Borrowers	263	2725	284	2247	-18
Nonborrowers	203	3062	219	2291	-25

Table 8. Average annual costs (PHP)[a] and returns per fisherman based on a sample of 505 borrowers and nonborrowers, Philippines, 1978–79.

Item	Borrower	Nonborrower	All fishermen
Total revenues	**10483**	**9516**	**10062**
Cash expenses	**6574**	**6332**	**6469**
Fuel	2998	2042	2581
Oil	133	106	122
Share of labour and equipment rented	1787	2801	2229
Kerosene	345	326	337
Bait	195	154	177
Ice	100	92	96
Food	556	424	499
Repair and maintenance of equipment	141	114	129
Fishing equipment and supplies purchased	41	48	44
Marketing expenses	278	225	255
Gross family income[b]	**3909**	**3184**	**3593**

[a]In 1979, 7.40 pesos (PHP) = US$1.

[b]Total revenues less cash expenses.

On income

On the average, borrowers earned a higher income than nonborrowers (10 500 vs 9500, Table 8). This was because a higher unit price (4.84 vs 4.22 PHP/kg) offset a slightly lower catch. Likewise, the gross family income of borrowers was somewhat higher than that obtained by nonborrowers (Table 8).

By region, borrowers from Central Luzon, Southern Tagalog, Bicol, Western Visayas, and Northern Mindanao grossed a lower income than nonborrowers. This might be attributed to the decline in their production due to lesser time spent in fishing as a consequence of high operating cost.

Several reasons were cited by the fishermen as to why their current fishing income was higher, the same, or lower compared with previous years. The same percentage (over 60%) of borrowers and nonborrowers whose income declined attributed the decline to low catch whereas 39% of the borrowers and 34% of the nonborrowers traced it to high operating costs. On the other hand, more than 30% of the borrowers and nonborrowers claimed that their income had increased, attributing the increase to higher prices for fish and a larger catch.

A minority of the borrowers and a majority of the nonborrowers complained that their income had leveled off. They claimed that, despite the higher prices of fish, production was lower giving them an income that was no different from that of previous years. At the same time, although some may have had increased production and should have earned more, the higher operating costs had reduced their returns to the same level as in the past.

The average family income, net of operating costs but gross of depreciation and other fixed costs, was estimated to be about 3600 PHP. Expenses — made up of fuel, hired labour, food for the operating owner and shareworkers, kerosene, bait, oil, and ice — primarily drained a large part of a fisherman's total revenues of 10 062 PHP. Another part was absorbed by marketing costs, maintenance of gear and equipment, as well as the rent or purchase of fishing supplies and equipment.

Costs were somewhat higher among borrowers, apparently because of their higher degree of motorization. The bulk of these expenses was made up of the cost of fuel, comprising 46% of the borrowers' fishing expenditures and 32% of the nonborrowers'.

After deducting all operating expenses, the gross family income was about 700 PHP higher for borrowers than for nonborrowers; although borrowers' expenses were higher, their total revenues were even higher giving rise to higher incomes.

To supplement the low income, 21% of the fishermen studied engaged in other nonfishing activities earning a gross amount of 2328 PHP/year. About 33% worked as labourers in fish ponds and road-construction sites and 22% engaged in business. Others were involved in farming (14%), carpentry jobs (11%), driving tricycles, jeepneys, or cargo trucks (8%), boat making and repair (6%), and wage employment (5%).

Proportionately, more borrowers were engaged in nonfishing activities and earned an average income of 2472 PHP/year compared with only 2095 PHP earned by nonborrowers. Wage employment was the major source of nonfishing income among nonborrowers whereas borrowers were engaged in both labour employment and business.

Attitudes and Standard of Living Indicators

To assess any attitudinal differences between borrowers and nonborrowers, fishermen were asked what their responses would be if a new practice or technology were introduced in their village. Of the sample fishermen, 50% would try it right away but the rest were more cautious in that they would let other fishermen try it first (27%) or ask for more information from other fishermen and fishery technicians (23%). The pattern was the same among borrowers and nonborrowers.

The difficulty in quantifying the change in living conditions, led us to ask qualitative questions such as whether living conditions had become better, worse, or remained unchanged. This was followed by enquiries into possible explanations. It seems that, over time, the living conditions of many fishermen have become worse (Table 9). Over 40% of the fishermen whether borrowers or not thought that their conditions had worsened and over 50% explained this by referring to the decline in catch, which was attributed largely to increased competition at the fishing grounds.

Some 22% of the borrowers and 14% of the nonborrowers reported a relatively improved standard of living as compared to the past. This they attributed largely to the acquisition of modern fishing equipment (especially by borrowers) but other reasons included the presence of supplementary sources of income, working children in the family, and improved marketing and transport infrastructure. The latter two reasons were more important to nonborrowers than borrowers.

Over 30% of the borrowers and 45% of nonborrowers claimed that, from 1974 to 1979, their standard of living had not changed, and cited the increased cost of basic family needs, and the unchanged volume of catch as reasons.

Despite the contention by 43% of the fishermen that their standard of living had become

Table 9. Present standard of living of borrower and nonborrower fishermen compared with 1974, Philippines, 1979.

Reasons for change	Borrower Number	Borrower %[a]	Nonborrower Number	Nonborrower %[a]	All fishermen Number	All fishermen %[a]
Number of respondents	**286**	**100**	**220**	**100**	**506**	**100**
Better	**63**	**22**	**32**	**14**	**95**	**19**
Acquisition of better fishing equipment	33	52	9	28	42	44
Other source of income	11	17	2	6	13	14
Working children	8	13	6	19	14	15
Better marketing facilities	8	13	6	19	14	15
Increase in volume of catch	7	11	4	12	11	12
Others[b]	8	13	8	25	16	17
Same	**92**	**32**	**101**	**46**	**193**	**38**
High cost of basic family needs	73	79	72	71	145	75
Volume of catch is same	14	15	20	20	34	18
Inflation	9	10	15	15	24	12
Frequency of children's illness	8	9	2	2	10	5
Worse	**131**	**46**	**87**	**40**	**218**	**43**
Volume of catch is smaller	63	48	50	57	113	52
High competition in fishing grounds	40	31	40	46	80	37
Inflation	43	33	38	44	81	37
Problems involving loan amortization	46	35	2	2	48	22
Bigger family	17	13	5	6	22	10
Other[c]	2	2	2	2	4	2

[a]Percentages total more than 100 because some respondents reported more than one reason.
[b]Includes: wife is also working, better price of catch, and aided by government's credit program.
[c]Includes: presence of pirates in fishing grounds, peace and order problems, and has own family.

Table 10. Percentage ownership of household facilities by borrower and nonborrower fishermen, Philippines, 1974 and 1979.

Item	Borrower (286)[a] 1974	Borrower (286)[a] 1979	Nonborrower (220) 1974	Nonborrower (220) 1979
Lighting facilities				
Kerosene lamp	70	63	78	71
Electric light	14	26	11	20
Kerosene pressure lamp	17	14	11	9
Others[b]	1	<1	0	<1
Water supply				
Public artesian well	73	73	70	71
Deep well (own water pump)	8	10	12	14
Piped water	11	11	9	8
Open well	2	1	0	1
Buying water	6	5	9	7
Cooking facilities				
Earthen stove	80	78	81	87
Kerosene stove	12	11	12	6
LPG stove	7	9	6	8
Electric stove	2	2	1	1
Toilet facilities				
Open pit	22	24	28	31
Closed pit	14	16	9	13
Flush or water sealed	8	15	9	14
None	56	45	54	42
Bathroom facilities				
With	5	10	4	7
Without	85	90	96	93

[a]Percentages total more than 100 because some respondents reported more than one answer.
[b]Includes battery operated and liquified pertroleum gas (LPG) lamp.

worse, a number of fishermen had been able to acquire their own houses. However, the proportion of lot-owners in the two groups of respondents increased only marginally — 3% since 1974. Among borrowers, the number renting their residential plot had grown only slightly, reducing by 1% the great number of squatters (49% in the past) living in the area. On the other hand, lot owners among the nonborrowers had increased from 16 to 19%.

Although the majority of the borrowers and nonborrowers had been lot squatters in the past, and still were in 1979, most of them owned their houses. In 1974, 84% of the borrowers and 75% of nonborrowers owned their houses and a small proportion rented houses or lived with relatives. By 1979, however, the proportion of both borrowers and nonborrowers who owned their houses had increased, to over 90%.

A number of improvements in household facilities had been enjoyed by the sample fishermen (Table 10). From a proportion of 14%, the electric-light users among borrowers had increased to 26% and among nonborrowers from 11 to 20%. Only marginal improvements in water supply took place among fishermen in both groups. There was also a modest improvement in cooking, bathroom, and toilet facilities (Table 10) but no significant difference between borrowers and nonborrowers was observed.

Moreover, several household appliances had been acquired by the sample fishermen. The most common of these items were a radio, phonograph, or tape recorder. Consumer durables that may well be considered luxuries, such as television, electric fan, or stereo, were acquired to a larger degree by borrowers than nonborrowers.

Summary and Conclusions

A massive financing program was undertaken by DBP starting in 1974 to cater to the needs of the small-scale fishermen and fish farmers in the country. Thus, 1974 was used as the base for comparison of changes in technology, productivity, and socioeconomic conditions that occurred in the municipal-fisheries sector. To evaluate the impact of credit, borrowers and nonborrowers were compared on the basis of qualitative information elicited from the respondents.

The impact of the credit program was analyzed using several indicators. First, boat ownership has increased: that is, comparing 1974 and 1979, more fishermen have been able to acquire boats presumably as a result of the credit package. This seems to have been especially true of those who borrowed from DBP whose credit program was so implemented that some fishing equipment had to be provided in kind. A few fishermen were even able to acquire more than one boat. Moreover, new boats were longer and of greater capacity than older boats. Second, more boats have been motorized, enabling fishermen to exploit more distant fishing grounds. The percentage change in boat motorization was remarkably high among borrowers compared with nonborrowers. New engines were also of greater horsepower. Third, the number and type of catching gear owned have improved. In terms of upgrading of technology, therefore, the credit program has been quite successful. With the newly acquired fishing equipment and other assets, capital investment in fisheries has expanded.

However, the credit program, and its impact on investment and technology, does not seem to have affected the catch or the income of fishermen as the volume of fish caught and income have remained practically the same — an outcome that fishermen attributed to a number of factors among which were the increase in fishermen's population, competition from trawlers, and fish scarcity due to pollution. The composite increase in fishing costs had diminished what could have been a more positive effect of the financing assistance to the fishermen. Repayment of loans, therefore, was low. What is important is not a marginal increase in income but a sufficiently high one to warrant the cost of credit.

Overview of Infrastructure Facilities for Fisheries Development in Sri Lanka[1]

A. Renton De Alwis

Although actual fishing operations remain almost entirely the responsibility of the private sector, since the early 1950s, the Government of Sri Lanka has taken responsibility for many facets of the industry: providing craft and gear on credit and subsidy schemes; planning and implementing programs for mechanization of craft; developing marketing and distribution facilities; constructing fisheries, harbours and anchorages; conducting fisheries training schemes for fishermen; providing welfare facilities; conducting fisheries research; and providing a legal framework for the optimal management of the fishery.

This paper is primarily concerned with assessing the efforts of the state sector to modernize the Sri Lankan fishery and provide infrastructural facilities so as to increase production and income. In dealing with these two subjects, a host of questions may well be raised concerning the reasons for the failure of the traditional fishery to attain the expected degree of modernization and for the interest shown by the state in fisheries development, and the pragmatic or ideological arguments that led to the creation of such public-sector institutions as the Ceylon Fisheries Corporation (CFC) and fishery cooperatives.

In describing the public-sector involvement in fishery modernization and provision of infrastructural facilities, we must examine all significant developments from the 1950s to the present. However, the reasons that led to particular decisions regarding policy are not treated exhaustively in this paper because many of them were linked to factors that operated at the political level.

The study relies on secondary data and especially on the master plan for the development of fisheries in Sri Lanka 1979–83 (Sri Lanka, Ministry of Fisheries 1980a).[2]

Since 1898, the state has played a supervisory and regulatory role in the fishery and, in 1941, a separate department of fisheries was established. Until the 1950s, the fishery remained at a subsistence level and the indigenous technology used permitted fishing only 8–16 km off the coast. As a result, Sri Lanka was far from being self-sufficient in its fish requirements during this period: in 1957, the catch of wet fish was 39000 tons whereas 106522 tons of dry fish were imported.

In 1958, a team of Japanese experts made several recommendations for making Sri Lanka self-sufficient in fish. Its 10-year development plan included mechanization of craft, training, research and development, and development of necessary infrastructure. Over the next 5 years (1959–63), fish output was nearly doubled, reaching 65460 tons in 1963. Most of the investment of 43 million LKR went to launch 2000 mechanized boats, and no investments were directed to the provision of infrastructural facilities (15.63 rupees [LKR] = US$1).

As a result of the "Short-term Implementation Programme" of 1962, CFC was established in 1964 and charged with fishing operations, fish processing, fish export and

[1]Abridged, from an earlier version, by Henry De Mel, Research Officer, Marga Institute, Colombo, Sri Lanka.

[2]The following sources were consulted in the preparation of this paper but are not cited specifically: Alwis (1979), Canagaratnam and Medcof (nd), Ceylon, Department of Fisheries (1951, 1952), Ceylon Fisheries Corporation (1965a, b), Colombo Museum (nd), De Bruin (1970, 1977), Goonawardena (1980), Kearney (1975), Marga Institute (1978), Moore (1970, 1980), Sae ters dal and De Bruin (1977), Sri Lanka, Department of Census and Statistics (1974), Sri Lanka, Ministry of Fisheries (1979a, b, c, 1980b), Sri Lanka, Ministry of Planning and Employment (1971), and Sri Lanka, Royal Commission (1970, 1978).

import, marketing, boat construction and repair, and provision of other essential infrastructural facilities. In 1965, the Corporation produced a 10-year plan with a total investment of 1600 million LKR to be financed from the Corporation's profits. However, because of a shift of emphasis from domestic supply to fish exports, CFC has operated at a loss since 1965 and the development targets were not achieved. In 1979, Sri Lanka's Ministry of Fisheries suggested that CFC had only a 10–15% share in the marketing of fish in the country; however, the true value was much less — around 5%.

The Ministry of Fisheries carries out the regulatory, extension, research, training, and welfare functions supporting the fishing industry. The Ministry designed a master plan for the development of the fishery during 1979–83 with the following objectives:

- To increase fish production and to raise the annual consumption to 20 kg/person.
- To raise the income and the quality of life of fishermen;
- To enhance employment opportunities in the fisheries sector; and
- To utilize fully the fishery resource potential.

Coastal, Offshore, and Deep-Sea Fishery Development

Because the coastal fishery — within 40 km of the coast — accounts for almost 90% of the total fish production, many of the master plan proposals are directed to this sector. For example, the mechanization program is directed to the coastal fishery and the provision of infrastructural facilities for coastal fishermen whose migration from the south and west coasts to the north and east coasts during the southwest monsoon is a notable feature of the coastal fishery. This migration results in the optimal utilization of boat capacity and exploits resources in areas where levels of fishing would otherwise remain low, while minimizing the threat of overfishing due to year-round concentration of fishing activities in limited areas.

Offshore fishery takes place between 40 and 100 km from the shore. The master plan envisages the deployment of several types of larger boats for exploiting the fish species that inhabit this area.

The area beyond 100 km from the coast is defined as the deep-sea fishery. Present exploitation is minimal and plans are being formulated to implement schemes with foreign aid to increase output from this area, especially through a tuna fishery. Granting licences to foreign vessels to fish in this area is also under consideration.

Modernization of fishing craft and gear

Between 1950 and 1955, the average annual fish production was 26 000 tons, and 90% of this was landed by traditional craft using traditional gear and fishing methods. The fishery development scheme formulated by the Department of Fisheries is based on the modernization of craft through mechanization and the introduction of new fishing methods and gear.

Implementation of this scheme devolved on the Department of Fisheries because the traditional financiers and leaders of the fishing community — the *mudalalis* (traders or middlemen) — did not have the risk-bearing capacity nor an adequate incentive to embark on this program.

The first pilot scheme aimed at modernization of the fishery was launched in 1955 with the introduction of 40 marine diesel engines installed in selected indigenous craft. The first government-sponsored loan scheme was initiated in 1957 primarily for mechanization of craft and purchase of modern gear. (Up to 1968, only 241 loans amounting to 201 900 LKR were issued under this scheme because stringent conditions were attached to issue of loans: however, 78% of the funds loaned were recovered.)

In 1958, the Department of Fisheries also initiated a separate loan scheme with less stringent conditions than the previous government scheme. In 1959, it was modified so as to issue boats on loan only through fishermen's cooperative societies to minimize the income disparities among fishermen. The hastily formed cooperatives proved to be a failure and issuing boats to individuals was resumed. From 1970, however, fishermen's cooperatives were again issued with boats under a new scheme. This continued until 1977 when, once again, the issue of boats on credit and subsidy schemes to individuals were resumed and superseded in importance the issue of boats to fishery cooperatives.

In 1978, a new scheme for issuing a subsidy for mechanization of fishing craft was formulated. Under a self-employment credit scheme, a state subsidy of 35% was granted with the initial down payment of only 7.8% of the total cost of craft and gear. The scheme was implemented through the two state-sponsored banks — the credit for purchase of hull, engine, and gear being channeled through them.

Since 1968, the number of boats purchased outright has exceeded that of boats on loan from the Fisheries Department. Since 1978 with the self-employment credit scheme and the mechanization subsidy of 35% outright purchase of craft with credit facilities provided by the two state-sponsored banks has increased rapidly. In 1978 and 1979 alone, 5309 boats — nearly the equivalent of all the issues of the previous decade — were added to the existing fleet.

The modernization of the fishery during 1955–80 is considered as a major contributory factor in increasing production more than sixfold with fish output rising from 29 627 tons in 1955 to 180 316 tons in 1980. In 1978, of the total 22 945 fishing craft in operation, 7210 (31.4%) were mechanized.

However, problems were encountered in the mechanization program. These included:

- Nonrepayment of loans issued for purchase of craft, engines, and gear;
- Difficulties in the selection of appropriate types of craft, engines, and gear for issue;
- The need for a policy on the issue of boats to avoid overexploitation of resources in certain areas and creation of disputes among fishermen.

Various schemes and devices adopted to ensure repayment of loans have proved futile.

The master plan for fishery development during 1979–83 envisages the progressive increase in the number of boats and engines going into operation (Tables 1 and 2). A liberal subsidy scheme ranging from 25 to 35% for craft and 50% for marine engines is operated through the master plan. The plan also identified the major constraints to modernization:

- Insufficient supply of spare parts and repair facilities;
- Nonavailability of fishing gear and lack of training in modern methods; and
- Increasing fuel prices.

In its plan, the ministry formulated various strategies to overcome the first two of these constraints. These included:

- An open general licence scheme for the import of engines and spare parts;
- A unit within the ministry to monitor the issue of engines and spare parts and to provide a market intelligence service to both fishermen and engine importers or agents;
- Reduction of the import duty on spare parts from 25 to 5%;
- Provision of credit facilities through banks to reputed garages or fisheries cooperatives to establish local spare-part distribution agencies; and
- Provision of assistance to establish engine-repair shops in areas where adequate facilities are not available.

Fishery harbours and anchorages

Until 1966, the mechanized boats introduced since 1955 (3500 3.5- and 1.5-ton boats) had few sheltered anchorages, except in a few major lagoons, where these boats could anchor all year round. These boats, as well as the proposed development of an offshore and deep-sea fishery, necessitated the construction of fishery harbours and anchorages.

In 1964, CFC was established and entrusted with fishery harbour construction. By 1972, four

Table 1. Estimated numbers of fishing boats in the coastal fishery, Sri Lanka, 1979-83.

	1979	1980	1981	1982	1983
3.5-tonner					
Boats at beginning year	2240	2305	2505	2619	2715
Boats going out in year	285	200	286	268	127
Boats introduced in year	350	400	400	400	400
17–24 foot fibreglass boats					
Boats at beginning year	2850	3250	3750	4250	4750
Engines replaced in year	150	250	360	660	610
Boats introduced in year	400	500	500	500	500
Mechanized indigenous boats					
Total boats at beginning year	3150	4290	4750	4980	5080
Engines replaced	160	290	410	740	690
Engines issued	1300	750	640	840	890
Craft mechanized in year	1140	460	230	100	200
Nonmechanized indigenous craft					
Boats at beginning year	13800	13230	13000	12885	12835
Boats mechanized in year	1140	460	230	100	200

Source: Sri Lanka, Ministry of Fisheries (1980a).

Table 2. Estimated output of coastal fishing vessels, Sri Lanka, 1979–83.

	1979	1980	1981	1982	1983
3.5-tonners					
Catch (tons/boat-year)	21	22	22	22	22
Operating crafts	2273	2405	2562	2685	2888
Total catch	47733	52910	56364	59070	63536
17-24 foot boats					
Catch (tons/boat-year)	11	12	12	12	12
Operating craft	3050	3500	4000	4500	5000
Total catch	33550	42000	48000	54000	60000
Mechanized indigenous craft					
Catch (tons/boat-year)	7.5	8	8	8	8
Operating craft	3720	4520	4865	5030	5180
Total catch	27900	35160	38920	40240	41440
Nonmechanized indigenous craft[a]					
Catch (tons/boat-year)	3.5	4	4	4	4
Operating craft	13515	13115	12943	12860	12785
Total catch	47303	52460	51772	51440	51140
Grand total catch	156486	183530	195056	204750	216116

Source: Ministry of Fisheries (1980a).

[a]Includes craft operating beach seines.

harbours had been completed. In 1972, the Ceylon Fishery Harbours Corporation (CFHC) was created and given overall charge of fishery-harbour construction and maintenance. By 1978, CFHC had completed three fishery harbours and planned to construct 17 more. However, this plan was not implemented due to prohibitive capital costs of harbour construction — they had risen sevenfold since the 1960s — and the slowed development of the planned offshore and deep-sea fishery. In addition, the existing harbours were underutilized for several reasons: the fishermen preferred to beach their 17–22 foot craft close to their residences for security; failure to obtain foreign funding for upgrading of facilities; managerial constraints in operating the programs for offshore and deep-sea fishing for which certain harbours were designed; and the effect of sociological factors, such as caste barriers, preventing access to harbours in certain areas.

The master plan emphasizes the development of river mouths and canal mouths with breakwaters, jetties, and shore facilities rather than the development of very costly fishery harbours. The plan also envisages increased utilization of existing harbours by providing facilities such as rest rooms, transport, and improved security and also by the issue of new craft to these areas. However, it must be noted that there is very little correlation between the issue of boats and areas served by harbours. The issue of boats has been predominantly governed by factors other than the availability of infrastructural facilities, and has resulted in the clustering of boats in certain locations. Apart from the factor of underutilization of existing facilities, concern has been expressed on boat issue with respect to over-exploitation of fishery resources in areas where boat issues have been extensive. This topic needs further research. Research and development goes on in the construction of a beachable 28–32 ft boat as well as larger craft.

Inland Fisheries Development

Fishing in inland water bodies (irrigation reservoirs, brackish water bodies, and estuaries) did not feature in government policy before 1978 other than as a means of supplying fish to areas where sea fish were not available. Since 1978, the potential of inland fishery, especially aquaculture and fish farming, for increasing fish production has been understood and its importance as an alternative to marine fisheries, because of increasing fuel prices, recognized. The increases in inland fish production have been dramatic — 3350 tons in 1960, 13 000 tons in 1974, and 20 000 tons in 1980. The target for 1985 is 50 000 tons. However, present consumer preference for only a few species of freshwater fish could hamper inland fishery development unless a continued and consistent marketing and product-development strategy is adopted.

Since the 1950s, inland water bodies have been stocked with *Tilapia mossambica* fingerlings supplied by breeding stations. During the 1970s, several fish-breeding stations were established and, in 1974, some fishery technicians from the People's Republic of China introduced the grass carp and the big head carp into Sri Lanka's inland water bodies.

The master plan has adopted a series of strategies aimed at developing the inland fishery. Chief among these are the establishment of more fish-breeding stations and stocking centres and subsidies for constructing ponds and for purchase of craft to be used in the inland fishery. Brackish-water fish culture is also to be developed and aquaculture, especially of prawn and lobster for export, might have a potential in view of the rapid depletion of the wild inland species being exploited at present. It is also recognized that a substantial investment is needed in research, training, extension, marketing, and processing to successfully implement the strategies for inland fishery development.

The Inland Fisheries Development Program is identified in the master plan as a project with long-term scope. It was expected that fish production from the marine fishery would reach its upper biologically sustainable limit of 25 000 tons/year in 1983. Thereafter, the major scope for expansion of domestic fish production is expected to be from the inland fishery. The rising cost of fuel and fishing boats also make the marine fishery more expensive than inland fishery development.

Fishermen's Cooperatives

Since the 1940s, fishermen's cooperatives have assisted fishermen in the production and marketing of fish. Between 1941 and 1947, there were 49 cooperatives supervised by the Department of Cooperatives and, after 1950, a separate Assistant Registrar of Cooperatives for Fishermen was appointed. Cooperatives covered activities such as net making and fish sales. Progress was limited, however, because of the incidence of default in repayment of loans.

In 1954, a Central Cooperative Fish Sales Union was established. In addition to marketing fish, it also imported fishing gear in competition with private dealers and serviced the sector with gear at competitive prices. In 1964, its functions were taken over by CFC.

Since 1958, whenever boats were issued only to cooperatives, small societies would spring up solely to take advantage of the policy; however, these cooperatives would disintegrate rapidly. Even primary cooperative societies, which since 1970 were issued with 3.5-tonners and expected to be economically viable, defaulted in loan repayment. In 1975, these cooperatives owed the Department of Fisheries 8.3 million LKR, the equivalent of 101 boats. Nonavailability of fishing gear and off-loading part of the catch are the reasons given for the poor production by cooperative-owned boats.

The present policy of the Ministry of Fisheries is to use the past experience to devise efficient, viable cooperative societies and to confine their activities largely to marketing and sale of equipment and gear. There is also a program of handing over cooperative-owned boats to their skipper–operators: this would reduce the involvement of the cooperatives in promoting the mechanization program. That the master plan has no stated policy on cooperatives also indicates the dwindling importance of cooperatives in fishery development.

Marketing and Distribution

The Department of Fisheries launched a fish-marketing program in 1941 to assist both the consumer and the producer. In 1944, this program was expanded by establishing purchasing centres, by provision of marketing advances[3] at no interest, and by granting loans to finance fishing operations.

Since 1948, fish marketing has become the main function of fishery cooperatives and the department's involvement decreased. The setting up of the Central Cooperative Fish Sales Union and CFC were major landmarks in state intervention in fish marketing. The objective of CFC in its 1965–75 plans was to invest in establishment of fish-purchasing centres, ice plants, cold stores, and refrigerated trucks. Although CFC wanted to break the monopoly of the middlemen-traders, it was able eventually to account only for a reported 15% share of fish marketing in the country — as noted earlier, this is probably much higher than the real value. State-sector intervention in fish marketing has not had any impact on market prices during normal market situations.

Marketing and distribution of fish is closely related to the availability of ice because most consumers prefer fish moved on ice to frozen fish. From 1941 to 1946, ice production was a private-sector enterprise and took place on a limited scale. In 1946, the Department of Fisheries established four ice plants and in 1954, three more. The Colombo North (Mutwal) facility, commissioned in 1957, was handed over to CFC in 1964. Fishery harbours constructed since then have been equipped with cold stores and ice plants. Since 1972, investment in ice

[3]Marketing advances are payments made to fishermen before the catch is sold.

plants has been shared between the state and the private sectors.

The master plan has given high priority to meeting the increasing demand for ice. It also stipulates several strategies for ensuring a fair price for the consumer and the producer. Drying fish, fish processing by the Institute of Fish Technology, cold stores, and building of buffer stocks at CFC are some of the principal means suggested.

Lack of data on production at fish-landing centres, consumer preference, and the regional distribution of demand, etc. have proved to be constraints in formulating an efficient fish-marketing and distribution network. An organized and up-to-date program to collect data for this purpose is urgently needed.

Welfare Facilities

In the past, fishermen were among the most impoverished groups of the country. Their poor quality of life was the result of several factors: low levels of income, inadequacy of infrastructural facilities and basic amenities, and the high-risk nature of the occupation itself.

The Department of Fisheries in 1941 had embarked on the provision of some infrastructural facilities such as roads and markets. It was only in the 1950s that specific programs were launched to raise the standard of living of fishermen through the provision of better housing, sanitary and health services, etc. In 1979, a separate division was created in the Ministry of Fisheries to carry out programs for fishermen's welfare and 3.275 million LKR was allocated for this purpose in 1980.

For 1979–80, the construction of houses for fishermen, community centres, drinking-water wells, beacon lights, fisheries banks, and extension societies were to be expanded. A journal for fishermen published in Sinhala, Tamil, and English has been initiated.

A socioeconomic survey of fishermen in 1972 and a survey of a fishing village in the Puttalam District in 1978 revealed the inadequate living space and temporary nature of fishermen's houses, and the inadequate educational and health facilities in fishing villages. The master plan has provided targets for constructing 10 800 houses, 1350 wells, and 80 km of new roads and set aside 126.9 million LKR for these purposes in 1979–83. However, because of the financial crisis faced by the government, 30.9 million LKR allocated for 1981 has been reduced to 1.9 million.

Fisheries Training

The first facility for fisheries training, the Fisheries Training Centre (FTC), was established in 1962 in Negombo with Japanese collaboration. In 1972, three more such centres were opened. These centres provided courses in fishermen's training (6 months) and boat repair (1 year). In various fishing centres, intensive field-training courses in fishing and in the operation and maintenance of engines were conducted.

A central training facility, the Sri Lanka Fisheries Training Institute (SLFTI), was established in 1974 with Japanese collaboration at Mutwal to cater to the training needs for the offshore and deep-sea fisheries. However, the personnel trained by SLFTI have not been utilized because the offshore and deep-sea fishery development plans were not fully implemented and because these people were overqualified for the coastal fishery. Equally, the courses at the FTCs were found to be too advanced for the needs of the coastal fishery and 60% of the trainees were engaged in occupations other than fisheries and so were lost also to the fishery sector. There is also very little coordination between the extension staff of the Fisheries Ministry and FTCs. A committee appointed to examine the SLFTI and FTC courses has recommended the reformulation of the present courses to suit the needs of the sector.

In view of the envisaged development program, as spelled out in the master plan, training is also needed in mariculture, freshwater fish-culture, and refrigeration, and research is needed on fuel-saving methods in the operation of engines, supplementary use of sails, efficient use of fishing gear, etc. A complete reassessment of the nature of the present organization of the FTC and SLFTI will have to be undertaken, and these organizations must be reorganized to have the flexibility needed to conduct more courses connected to the dissemination of information related to the needs of the fishery sector.

Research and Development

For the first half of this century, fisheries research in Sri Lanka was biological and academic in content and was confined to the more lucrative types of fishing, e.g., pearl, chank, shark, and oyster fisheries.

Although results from the Fisheries Research Station were published in its own bulletin, there was a gap between research and extension needs. A special unit was created in the 1960s to remedy this situation and to support research on fishing methods, gear, handling, processing, and distribution. This unit has been expanded and is now the Fish Technology Institute.

Although intensive research on individual species has been the predominant feature in Sri Lanka's fisheries research, very little has been done in terms of resource surveys to identify the nature, the availability, and the distribution of fish resources. Although financial allocations were made each year by the ministry for a resource survey, for a long time the survey was not conducted because a research craft and suitably qualified personnel were not available. However, in 1978, assistance was sought from Norway through the Norwegian Agency for International Development to obtain the services of the fishery research vessel *Dr Fidtjof Nansen* and three limited surveys were carried out on the coastal fishery resources by this vessel in 1978–79.

The master plan proposes to establish programs in exploratory fishery, oceanographic research, and management of prawn and lobster resources. Inland fisheries, water bodies, pond culture, culture of multiple species, pest control, etc. are also part of this research. Research into craft and gear, fishery harbours, and fish handling and processing are also proposed.

According to the policy statement of the master plan, establishment of a centralized fisheries research institute, known as the National Aquatic Resource Development Agency (NARA), was recommended to undertake research and development activities in marine fisheries, inland fisheries, aquaculture, oceanography, aquatic and coastal environment, and socioeconomic aspects of the industry. It would also deal with information dissemination and data collection and processing. NARA has been instituted recently.

Foreign-Aid for Fishery Development Programs

Foreign assistance has been principally utilized in the area of fisheries training. With Japanese assistance, the first Fisheries Training Centre was established in Negombo and expanded in 1975. FAO/UNDP sponsored a project to train fishermen in developing skills necessary for a skip-jack bait fishery in 1973. The Cey Nor Project of 1967 in Jaffna for boat construction, ice production, fish processing, and net manufacture has been the best adapted foreign-funded project to develop fishery training. In 1974, another FAO/UNDP project sponsored training of personnel for aquaculture. In 1976, the People's Republic of China sponsored the Experimental Fish Breeding Station; FAO/SIDA sponsored one project to minimize fish spoilage and promote better fish-handling and processing techniques and another on the development of traditional fishery communities; and FAO/UNDP sponsored small-scale fishery development.

The Asian Development Bank and the Governments of Abu Dhabi and of the Netherlands have pledged to finance, through 1980–83, the introduction of several trawlers, drift netters, and other craft. Some other projects that will require foreign assistance have been formulated, e.g., deep-sea tuna-fishing project, mariculture development, fishery resource survey, etc.

Although foreign-aided projects accomplish much in short-term benefits, there has been little or no middle and long-term impact on the fishery economy. This is due to the lack of continuity and consistency in policy toward fishery development and the lack of proper assessment of the actual needs of the sector and a clear identification of priority areas.

For these reasons, there was a considerable gap between the aid flows and absorptive capacity, and between benefits expected and benefits derived. Most projects were too large or sophisticated for the sector's requirements at the time they were planned and implemented and, therefore, they did not have the capacity to merge with the stages of development of the local fishery, an essential factor in the successful implementation of foreign-funded projects.

Fisheries Legislation

Fisheries legislation in Sri Lanka consists of Ordinances and Acts of Parliament and Regulations made from time to time for the management and administration of the fishery under the provisions of these Ordinances and Acts.

General Regulations framed in 1941 and amended or supplemented in 1953, 1955, and 1973, govern the implementation of the Fisheries Ordinance, which was drawn up in 1940. Among other things, these regulations provide for:

- Stipulations for applying for and the issue of fishing licences;
- Stipulations for registering fishing boats;
- Requirements for marking of nets and gear for identification;
- Issue of import and export permits for live fish or fish eggs;

- Procedure of appeal against the decisions of fisheries officials; and
- Specification of conservation measures for selected species.

The Inland Water Fishing Regulations, framed in 1978 and 1979, list the major reservoirs and inland water bodies suitable for fishing and stipulate permit procedures and conditions of fishing.

District Regulations are detailed regulations for specific local conditions framed by the district administration under the Fisheries Ordinance and other earlier legislation, e.g., Game Protection Ordinance of 1908 and the Village Committees Ordinance of 1889. In addition to these regulations, other legislation exists for specific sections of the fishery, such as the Whaling Ordinance of 1936 and the Chank

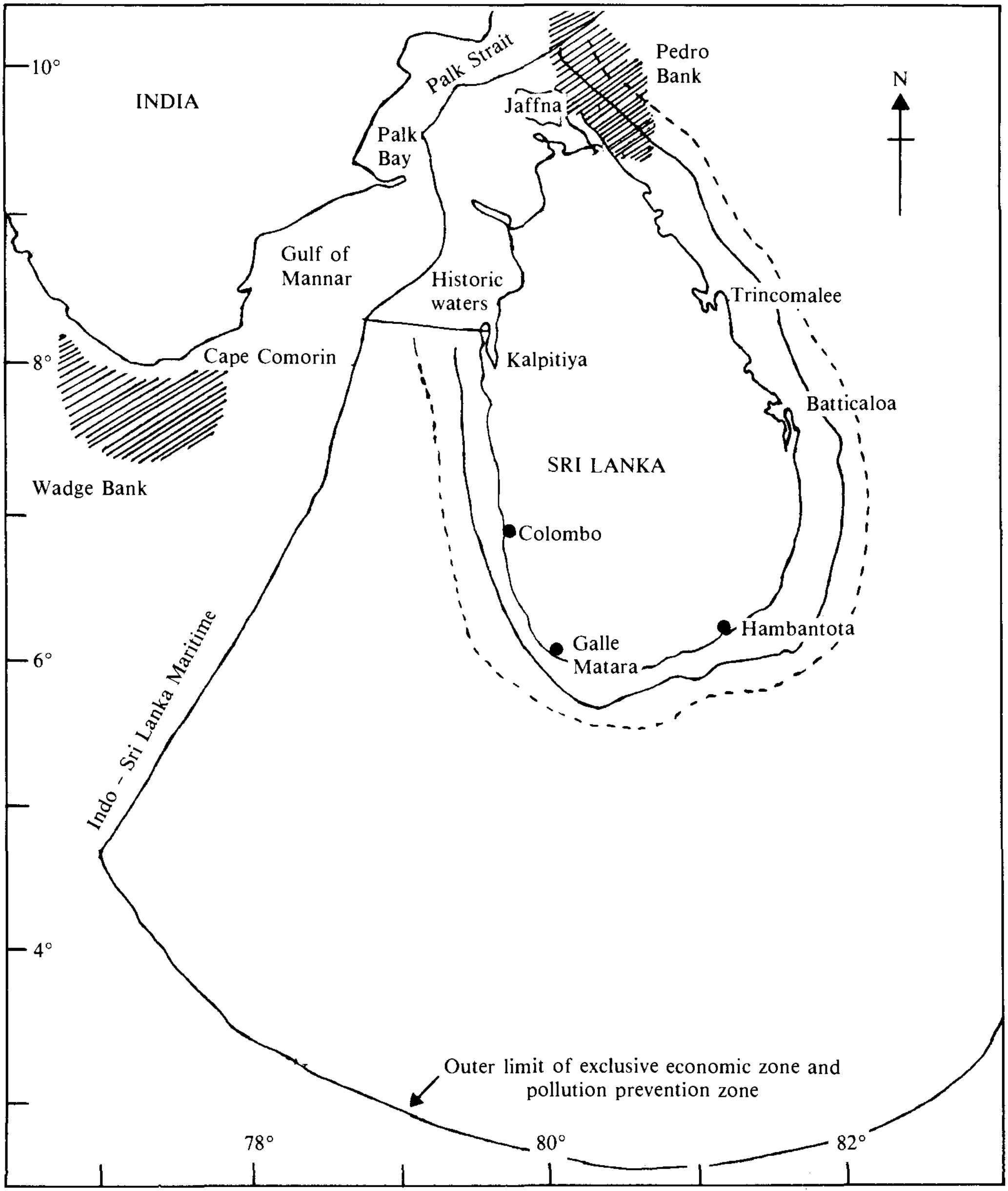

Fig. 1. Maritime boundaries of Sri Lanka showing the Exclusive Economic Zone (from Sri Lanka, Ministry of Fisheries 1980a).

Fishery Act of 1953.

The Fisheries Ordinance, referred to above, had 3 nautical miles (about 5.5 km) of coastal waters under its jurisdiction until the enactment of the Maritime Zones Law Number 22 of 1976, when the limits of the territorial sea were extended to 12 nautical miles (about 22 km, see Fig. 1). However, arrangements are being made to extend the jurisdictional powers of the Ordinance to cover the entire Exclusive Economic Zone of Sri Lanka (200-mile limit, 370 km).

In 1978, the Government of Sri Lanka requested assistance from the UNDP/FAO Indian Ocean Programme and the FAO/Norway Cooperation Programme to support jointly the preparation of draft legislation that would improve on the Fisheries Ordinance to facilitate the control of local and foreign fishing operations within the country's Exclusive Economic Zone. A legal consultant has prepared draft legislation — the Fisheries General Provisions Draft Bill — which is being refined before presentation in Parliament for enactment. A laudable feature in the consultant's report on the draft legislation is an addendum suggesting consultations with fishermen on the proposed legislation.

Legislation is also being finalized for the establishment of the National Aquatic Resources Development Agency with a Director-General for its administration within the Ministry of Fisheries.

Policy Implications[4]

The provision of infrastructural facilities and services for offshore and deep-sea fisheries should be geared to a carefully worked out offshore and deep-sea fishery development plan. This plan should be based on comprehensive resource surveys of the available resources.

When issuing mechanized boats to different landing centres in the island, the criterion of equity as well as that of efficiency of operation should be taken into account. On the one hand, nonavailability of infrastructural facilities and services, such as ice-plants and harbours, near certain landing centres will lead to operational inefficiency and low incomes for operators of boats issued to such areas; on the other, considerations of equity require that areas that already have well developed facilities should not get boats at the expense of less-developed areas, which would be overlooked on grounds of operational efficiency alone. Policy should be guided by a trade-off between equity and efficiency of operation. Boats could be issued to less-developed landing centres as part of a development package that combines the issue of boats with the provision of infrastructural facilities and services to such areas.

Seasonal migration of fishermen from relatively overexploited centres to relatively underexploited ones should be encouraged through the provision of infrastructural facilities in such selected migrant centres.

State intervention in fish marketing (including the provision of support facilities such as ice production) should take place within the context of a carefully formulated national fish marketing and distribution plan, which, in turn, should be based on an analysis on data on fish production at landing centres, consumer preferences, regionality of demand, etc.

Modernization and increased production in the coastal fishery appear to be achieved more successfully through individual ownership of the means of production than through cooperative systems of ownership.

Training courses for fishermen should be realistically structured to suit the requirements of practical fishermen by making them the outcome of an institutionalized, two-way communication process between the trainers and the fishermen. Such a communication process can be structured through the extension arm of the Ministry of Fisheries.

A continued and consistent marketing and product-development strategy should be a critical part of the inland fisheries-development program in a country where consumer bias against freshwater fish is strong.

If legislation for fisheries management is to be meaningfully and realistically formulated, it must be done in close consultation with fishermen.

A continuous and consistent policy toward fisheries development must be based on a clear assessment of the actual needs of the sector and an identification of the priority areas, and it is within such a context that foreign-funded projects should be structured so as to meet the sector's requirements at the time of implementation.

Because the increasing cost of fossil-based fuel is a major limiting factor in fisheries development, efforts by the research arm of the Ministry of Fisheries must be sustained, on a priority basis, toward developing a less fuel-consuming technology for the coastal fishery.

[4]This part was written by Sunimal Fernando and, therefore, is not the responsibility of the author of the rest of this section.

Aquaculture

Differential Productivity and Income Generation of Fish Culture Technology in the Philippines

Aida R. Librero and Nicostrato Perez[1]

The fisheries industry in the Philippines consists of three sectors, municipal or small-scale capture fisheries, commercial fisheries, and aquaculture. Although the first two sectors contribute over 90% of total fish production, aquaculture holds a great potential in increasing fish supply in the country. The target set in the Expanded Fisheries Development Program for the increase in aquaculture production was 10.8% per year, a higher growth rate than for any other sector.

Unlike capture fisheries, aquaculture is not a fuel-intensive economic activity. However, rising fuel prices also affect aquaculture through its influence on the price of fertilizer, an important input in fish production. In addition, fry supply apparently has been inadequate, resulting in high prices. Yields have been low, averaging only 656 kg/ha per year against a potential of 2000 kg/ha per year.

Beset by the pressure of increasing food demand, aquaculture's overwhelming concern is to increase food production either through extensive or intensive culture. Increased production through expanding the area under culture means a proportionate increase in the exploitation of limited swampland and mangrove areas. However, studies show that existing fish ponds are not operated at full capacity in terms of either area or productivity — on average, 13% of the total area of a fish farm is not operational (Librero et al. 1977).

An assessment of the adoption, utilization, and economic performance of aquaculture technology is therefore necessary and this paper attempts to identify the various technologies applied in fish farms and determines their productivity and profitability. Fish ponds in the Philippines are predominantly brackish-water ponds devoted to the culture of milkfish (*Chanos chanos*) — although milkfish are also cultured in fish pens in Laguna Lake, a different type of culture. This study focuses on the brackish-water ponds.

Sampling Methodology

Data for the study were obtained through personal interviews of a sample of fish-pond operators. Although most of them operated small farms, generally 10 ha or less, a few large farms were included in the final sample. The sampling frame was based on the extent of borrowing from the Development Bank of the Philippines (DBP). Using a multistage sampling technique, the provinces with the largest number of small-scale fish farms were chosen from each region. From each province (see fig. 1, p. 37), two to three municipalities with the largest number of small fish ponds were selected and from each municipality, 5–10 fish-pond operators were randomly chosen from available lists of DBP and the Bureau of Fisheries and Aquatic Resources (BFAR).

A total of 197 respondents from 33 municipalities were personally interviewed and data from 193 used in the analysis. Information on fish farms refer to the year 1978–79. Because small farms were specifically selected, about 30% were 2 ha or smaller and 25% were 2.01-5.00 ha.

Fish ponds were either privately owned through purchase or inheritance, or leased from either the government or private individuals.

[1]We thank the International Development Research Centre (IDRC) for providing financial support; the Development Bank of the Philippines and the Bureau of Fisheries and Aquatic Resources (Philippines) for providing the sampling frame and identifying the respondents for the project; the other researchers and staff of the project who participated in interviewing respondents and analyzing the data; and the fishermen and fish-pond operators who unselfishly responded to our many questions.

Because small farms are usually privately owned, the majority (81%) of the fish farmers studied were owner-operators.

Fish Pond Technology

The types of technology in aquaculture revolve around the management of inputs, such as fry or fingerlings, fertilizers, feeds, and chemicals (Table 1); soil and water management; and pond engineering.

Rates of production per farm and per hectare (based on both operational and rearing areas) for the various cultural practices and types of technologies followed are compared on the basis of averages; however, no statistical tests of significance were made. Production covers a 1-year period (April 1978–March 1979).

The 193 ponds sampled were classified as to the mode of culture practiced, that is, either monoculture or polyculture. In monoculture ponds, only a single species is cultured, in this case milkfish or *bangus* (*Chanos chanos*), whereas in polyculture ponds more than one species — usually milkfish in combination with either prawn, crab, or *Tilapia* — is raised.

Polyculture farms were almost twice as big as monoculture farms but had an output only 50% higher (9389 vs 6357 kg). Thus, on a per-hectare basis, monoculture farms were about 50% more productive than polyculture farms (1034 vs 700 kg/ha, Table 2). This is probably not because of the mode of culture per se but because a greater proportion of monoculture than polyculture farms applied fertilizer.

Geographically, farms in Western Visayas produced the highest yield (1917 kg/ha of rearing area) followed by Ilocos (1161 kg/ha) for monoculture farms; this was partly because these regions had more rearings per year than the other regions. In addition, fish farmers in Western Visayas appeared to be more responsive to technological change. Western Visayas also obtained the highest yield from polyculture (1867 kg/ha), followed by Central Visayas (1090 kg) and Bicol (585 kg).

By farming practice

Three types of natural food are grown in fish ponds in the Philippines — *lablab, lumut,* and plankton. *Lablab* is a biological complex of benthic algae and zoo plankton grown in shallow ponds of about 5–25 cm depth. *Lumut* is the local term for filamentous green algae sown on the bottom of ponds with a water depth of 25–50 cm. Plankton is the collective term for all microscopic organisms floating on the surface of the water or dispersed throughout it.

Lablab is the most popular feed and is grown in 80% of the sample ponds, *lumut* was grown in 8%, and the rest of the respondents grew a combination of *lablab* and *lumut*. None of the respondents grew plankton in their ponds, probably because it requires deeper water, which makes pond construction quite expensive, and is therefore unpopular. Whether in monoculture or polyculture ponds, *lablab* was the most productive feed giving an annual fish production of more than 1000 kg/ha of rearing area (Table 2). Fertilized monoculture ponds produced 1192 kg/ha compared with 488 kg/ha by unfertilized ponds. A similar pattern was observed in polyculture ponds.

Disregarding the type of food grown, monoculture ponds supplied with chemicals to eradicate pests gave higher production than those not supplied with any chemicals (1100 vs 820 kg/ha). However in polyculture ponds, the reverse was observed. It is possible that species like shrimps or prawns in polyculture ponds are sensitive to these chemicals; it could also be due to a difference in the severity of the pest problems between the two groups.

Table 1. Distribution (%) of types of technology employed by sample fish farms by region, Philippines, 1978–79.

Region	Technology[a]						
	A only	B only	C only	A + B	A + C	A + B + C	None
Ilocos	10	0	0	88	0	0	2
Central Luzon	5	0	2	26	5	58	3
Southern Tagalog	6	18	6	35	0	24	6
Bicol	0	27	9	9	27	18	9
Western Visayas	0	2	0	83	0	15	0
Central Visayas	20	0	0	70	10	0	0
Western Mindanao	42	0	11	11	14	0	21
Southern Mindanao	55	10	0	10	10	0	15
Philippines	14	5	2	49	6	17	6

[a]A = fertilization; B = pest eradication by use of chemicals; and C = supplementary feeding.

Table 2. Yield and profitability per hectare of fish culture by farming practice, Philippines, 1978–79.

Farm practice	Monoculture: Number of farms[a]	Monoculture: Rearing area (ha)	Monoculture: Yield[b] (kg/ha)	Monoculture: Gross revenues[c] (PHP/ha)	Monoculture: Farm expenses[c] (PHP/ha)	Monoculture: Net income[c] (PHP/ha)	Polyculture: Number of farms[a]	Polyculture: Rearing area (ha)	Polyculture: Yield[b] (kg/ha)
All ponds	164	6.15	1034	5705	2079	3626	29	13.42	700
Feed									
Lablab	143	6.23	1047	5783	2006	3777	12	6.16	1154
Lumut	9	7.11	989	5632	2782	2850	6	16.92	968
Combination	12	4.50	875	4988	2512	2476	11	19.98	430
Fertilization									
With	149	6.22	1192	5984	2181	3803	18	15.05	838
Without	15	5.48	488	2690	983	1707	11	10.75	382
Pest eradication									
With	119	6.47	1100	6024	2238	3786	22	12.86	568
Without	45	5.31	820	4671	1566	3105	7	15.17	1052
Supplementary feed									
With	39	9.51	1059	5661	2623	3038	12	18.75	689
Without	125	5.10	1019	5730	1763	2967	17	9.66	715
Input use[d]									
None	8	4.56	520	2386	755	1631	2	4.21	431
A only	27	5.94	841	5102	1364	3738	1	7.50	2244[e]
A + B	86	4.66	1194	6565	2074	4491	9	13.00	720
A + C	8	4.78	1050	5658	3231	2427	2	3.73	1152
A + B + C	28	11.68	1068	5712	2573	3139	6	11.84	552
Type of seed									
Fry	126	5.57	1161	6626	2072	4554	25	14.81	698
Fingerling	30	9.34	693	3428	1982	1446	3	5.49	794
Combination	8	3.27	1275	7225	3237	3988	1	13.42	700
Type of stocking									
Bulk stocking									
Fry	105	6.38	1204	6630	2236	4394	–	–	–
Fingerlings	10	13.40	915				–	–	–
Stagger stocking									
Fry	58	5.80	1035	4117	1818	2299	–	–	–
Fingerlings	20	7.28	488				–	–	–
Stocking rate (bulk)									
<1000	7	7.48	520	1838	1177	661	–	–	–
1000–2000	28	6.45	800	4112	1598	2514	–	–	–
2000–4000	38	3.62	1460	5555	2115	3440	–	–	–
4000–6000	15	3.81	1298	7768	2854	4914	–	–	–
>6000	7	15.42	1837	11057	3130	7927	–	–	–
Rearings per year									
One	22	6.33	325	1828	979	849	7	17.71	368
Two	47	16.72	828	4393	1996	2397	16	27.21	705
Three	89	14.34	1394	8057	2512	5545	3	33.04	583
Four	4	9.03	1569	9078	1961	7117	3	22.07	3332
Pond size									
<2	55	1.08	1275	8672	2441	6231	1	0.40	530
2–5	38	3.11	898	5446	2374	3072	10	3.06	748
5–10	39	5.90	1334	7661	2432	5229	8	6.64	1445
10–20	24	10.98	940	4181	1921	2260	2	11.00	205
>20	8	41.92	916	5325	1812	3513	8	35.39	603

[a]Totals for individual farm practices may differ because only responding farms are reported or, in some cases, several practices may be used on one farm.
[b]Per hectare of rearing area.
[c]Per hectare of operational area.
[d]A = fertilization; B = pest eradication by use of chemicals; and C = supplementary feeding.
[e]Should be regarded with caution as it is based on a sample of only one farm.

Of the different types of combined technologies (see Table 1), technology A + B, that is fertilization application and pest eradication by use of chemicals, was the most widely used practice in monoculture ponds (49% of sample). This was followed by technology A + B + C, the combination of fertilizer application, pest eradication by chemicals, and supplementary feeding (17% of sample). About 6% of the ponds did not apply any of these inputs.

In terms of production, technology A + B (fertilizer and chemicals) gave the highest yield (1194 kg/ha), and was more than twice as productive as technologies not using any purchased inputs (Table 2). It appears that fertilization contributed more to productivity when combined with pest eradication or supplementary feeding, or both, than when used alone.

Because the sample of polyculture farms was small, it is rather difficult to derive conclusions from these results. In general, however, fertilizer application gave high yields (Table 2). The practice of fertilization and supplementary feeding yielded an annual production of 1152 kg/ha. Unlike monoculture ponds, polyculture ponds not applying any of these inputs obtained a higher production than those employing technologies B, C, or B + C. It is likely that other factors, such as stocking density, affected the productivity of these inputs.

By type of stock and cropping intensity

Of the ponds sampled, 78% were stocked with fry alone, 17% with fingerlings alone, and 5% with combined fry (12–16 mm) and fingerlings (50–100 mm). The chief reason for using fry had to do with relative prices: 40-200 PHP/1000 pieces of fry compared with 250-350 PHP/1000 pieces of fingerlings (7.38 pesos [PHP] = US$1). Added to this were the seasonal availability of fry, the concentration of nurseries in Central Luzon and Southern Tagalog, and the characteristic ability of fry to be stocked in bulk and stunted for a long period.

Fry-stocked ponds were decidedly more productive than those stocked with fingerlings for monoculture (1161 vs 693 kg/ha, Table 2), but for polyculture fingerlings were slightly more productive (794 vs 698 kg/ha).

In monoculture ponds, use of pest eradication gave a 52% increase in production with fry but doubled production when stocking was with fingerlings. For combined fry and fingerlings, no comparison could be made because all farms sampled had applied chemicals. Similarly, fingerlings and combined fry and fingerlings stocked in polyculture farms were all treated with chemicals. In fry-stocked polyculture farms, those treated with chemicals (70%) had 42% lower production, which might have been due to the adverse effect of pesticides on the stock and the natural food in the pond (assuming other things to be equal).

Intensive culture means greater production not only per unit area but also per unit of time. A shorter rearing period means more rearings in a year and a maximum utilization of available pond area. The present practice stretched from one rearing per year (reported by 15% of the respondents) to six rearings per year (reported by 10%), but three (48%) or two (33%) rearings per year were the most common. For all farms, the average was 2.17 rearings per year.

In monoculture ponds, the largest number of rearings per year (four) gave the highest annual production (1569 kg/ha, Table 2). This was 175 kg greater than the yield from three rearings and almost twice that of two rearings.

By farm size and type of stock

The manageability of fish ponds and the intensity of operation are a function of farm size. As expected, total production per farm increased directly with farm size, that is, the larger the farm, the higher was the output. On a per-hectare basis, however, the smaller farms were found to be more efficient, which could be attributed to the more intensive operation of these farms.

Stocking of fry could be made either "in bulk" or "staggered." "In bulk" involves stocking nursery ponds with a large quantity of fry and then releasing some of the fry to either transition or rearing compartments at the start of every rearing period. In "staggered" stocking, however, new seed just sufficient for the rearing area is added at the start of the rearing period.

Most farms used bulk stocking: of these, 90% used fry and only 10% used fingerlings. Bulk stocking enables the fish-pond operator to purchase fry in large quantities during periods of low prices. Of those practicing staggered stocking, 42% used fry, 34% used fingerlings, and 14% use both.

In terms of annual production per hectare, bulk stocking gave slightly higher yields than staggered stocking. This is, however, also related to the stocking density (Table 2). Of the farmers practicing staggered stocking, those stocking both fry and fingerlings obtained higher production than those who stocked only fry or only fingerlings. In farms where bulk stocking is impossible because large quantities of seed are unavailable, the use of a combination of fry and fingerlings as stocking material is preferable.

Cost Structure and Profitability

Capital investment in milkfish ponds consisted mainly of land, farm buildings, and transport facilities. Excluding land, the latter two comprised 48 and 41% of the total investment, respectively. Farm buildings included the caretaker's house, workers' sheds, and guard houses, and transport facilities consisted of *bancas,* boats, engines, and some vehicles for big farms. On the average, the value of farm investment excluding land amounted to 6122 PHP/farm or 703 PHP/ha.

Cash receipts were derived solely from the sale of fish. Noncash farm receipts included the value of fish consumed at home, given away as gifts, or used as payment in kind for services rendered by harvesters and labourers. Annual gross revenues for monoculture farms averaged 43 415 PHP/farm or 5705 PHP/ha of which 97% was cash and 3% noncash (Table 3). Of the noncash receipts, the value of fish given away constituted almost 50% of the total. For monoculture ponds, those in Ilocos had the highest gross revenues (9943 PHP/ha) and those in Bicol had the lowest (970 PHP/ha, not reported in Table 3).

For the Philippines as a whole, gross revenues from polyculture ponds averaged 8439 PHP/ha, which was 48% higher than that generated by monoculture ponds. This could be attributed to the higher yield realized by polyculture ponds. On a regional basis, Western Visayas was the most productive polyculture area and Southern Luzon the least productive (total receipts of 25 432 vs 4820 PHP/ha), a situation reflecting production rather than price differential.

Operating costs of monoculture farms were almost 2500 PHP/ha with approximately 91% paid in cash and 9% noncash (Table 3). Of the cash expenses, 92% were used in the operation of the pond and 9% in the marketing of the produce. Although Western Visayas achieved the highest production, it also incurred the highest expenses (3973 PHP/ha), 27% of which was accounted for by the cost of the stock. The lowest expenses per hectare were observed in Bicol monoculture (not reported in Table 3), where operating expenses were limited only to the cost of stock, pesticides, supplies, and hired labour.

Operational costs in polyculture ponds were 60% higher than those incurred by monoculture ponds. Marked differences could be observed in the cost of stock because prawn and crab were more expensive than milkfish. Likewise, marketing costs, such as transport and broker's fees, were higher for polyculture ponds.

Subtracting cash costs from total revenue gives the gross income. Because of their larger operational area and higher productivity, polyculture farms realized higher gross income, averaging 69 008 PHP/farm for the entire Philippines (Table 3), than monoculture farms.

Net income was computed by subtracting depreciation costs from gross income. It amounted to 68 234 PHP/farm in polyculture ponds and 25 557 PHP/farm in monoculture ponds. Net economic profit, obtained by subtracting total costs from total revenues, amounted to 24 888 PHP/farm or 3266 PHP/ha for monoculture ponds and ranged from 54 PHP/ha in Bicol (not reported in Table 3) to 8041 PHP/ha in Ilocos. The low profitability in Bicol can be explained by the less intensive cultural practices employed: no fertilizer or supplementary feeds were used, only one crop per year was reared, and very low stocking rates were practiced.

Polyculture ponds, on the other hand, realized an average net economic profit of 67 030 PHP/farm or 4532 PHP/ha: 29% higher than that obtained from monoculture ponds. Western Visayas realized the highest profit and Southern Tagalog farmers earned the lowest profit of all the regions, again due to their very low production.

A measure of profit that does not depend on the unit of measurement is percent return to capital. This amounted to 438% in monoculture ponds and 1164% in polyculture if land value is excluded (Table 3). Because polyculture ponds had higher productivity and net profit, they similarly had higher return to management. This amounted to 185 PHP/man-day compared with 68 PHP/man-day realized by monoculture ponds.

Once land has been developed and culture operations have been stabilized, the short-run rates of return are quite high. Such high returns have encouraged investors to open up new lands for fishponds. Entry into the fishpond business, however, has been limited by the government's attempt to conserve mangrove areas. Other barriers to entry include large capital requirement and insufficient fry supply.

Table 3. Cost structure and profitability (PHP/ha of operational area unless stated otherwise)[a] of fish culture by region and type of culture, Philippines, 1978–79.

	Ilocos (mono-culture)	Central Luzon (mono-culture)	Southern Luzon (poly-culture)	Bicol (poly-culture)	Western Visayas		Central Visayas (mono-culture)	Northern Mindanao (mono-culture)	Southern Mindanao (mono-culture)	All regions	
					Mono-culture	Poly-culture				Mono-culture	Poly-culture
Number of farms	39	37	13	10	35	5	9	19	20	164	29
Average operating area (ha)	1.65	15.17	11.31	25.05	5.07	6.40	3.84	11.81	6.44	7.61	14.90
Variable costs (VC)	**1707**	**2286**	**2157**	**3979**	**3393**	**5490**	**2755**	**963**	**1665**	**2079**	**3505**
Labour	135	226	516	697	511	1172	1424	401	592	383	714
Stock	588	922	758	1228	1052	3302	327	176	423	695	1215
Fertilizer	240	547	322	517	858	172	427	209	166	452	422
Chemicals	47	195	73	32	70	80	38	18	38	109	50
Feeds	0	66	10	91	3	2	17	5	< 1	36	56
Marketing	556	194	144	654	335	289	54	8	113	179	450
Others	123	124	330	760	405	332	422	139	314	190	586
Family labour	18	12	4	0	159	141	46	7	19	35	12
Fixed costs (FC)	**195**	**274**	**217**	**398**	**580**	**689**	**475**	**187**	**552**	**360**	**402**
Interest on debt	127	57	160	335	407	496	243	86	344	184	321
Depreciation	47	150	36	39	123	134	161	70	144	123	52
Opportunity cost of own capital	21	67	21	24	50	59	71	31	64	53	29
Total costs (TC)[b]	**1902**	**2560**	**2374**	**4377**	**3973**	**6179**	**3230**	**1150**	**2217**	**2439**	**3907**
Cash (C)	1816	2331	2313	4314	3641	5845	2942	1042	1990	2228	3814
Noncash (NC)	86	229	61	63	332	334	288	108	227	211	93
Gross revenues (GR)	**9943**	**5025**	**4820**	**8213**	**9476**	**25432**	**5048**	**3928**	**6119**	**5705**	**8439**
Cash	9411	4797	4764	8172	9280	25846	4843	3858	6016	5515	8350
Noncash	532	228	56	41	196	586	205	70	103	190	89
Profit											
Operating (GR - VC)	8236	2739	2663	4234	6083	19942	2293	2965	4454	3626	4934
Net (GR - TC)	8041	2465	2446	3836	5503	19253	1818	2778	3902	3266	4532
Pure[c]	1859	1793	1544	3429	3491	17659	838	1914	2318	1926	3847
Returns											
To capital (%)[d]	706	216	623	1336	594	2443	-54	495	321	438	1164
To management (PHP/day)	36	102	76	302	77	355	19	90	69	68	185
Income (PHP/farm)											
Gross	13377	40889	28417	111887	29701	131760	8156	34138	26589	26494	69008
Net	13300	38619	28009	110909	29075	130904	7538	33313	25660	25557	68234

[a]7.38 pesos (PHP) = US$1.
[b]Total costs can also be expressed as total fixed costs (FC) + total variable costs (VC).
[c]Net profit minus the opportunity cost of management (assumed 10 200 PHP/farm manager per year; or per hectare, 10 200 PHP divided by farm size).
[d]Excluding land.

Costs and Returns by Farming Practice and Farm Size

In this section, we compare measures such as receipts, expenditures, and net income for inputs such as fertilizers, pesticides, and supplementary feeds. Comparison of measures of profits considered only monoculture ponds because the sample of polyculture ponds was relatively small and the differences in the price of the different species cultured in these ponds was large. On the average, milkfish was sold at 6.79 PHP/kg, prawn at 62.36 PHP, crab at 9.94 PHP, and other species at 5.58 PHP.

Regardless of the other inputs used, fertilizer users received, on the average, farm receipts of 5984 PHP/ha, which were more than twice those of nonfertilizer users (Table 2). Although expenses were much higher due to the added inputs and higher marketing costs, net farm earnings realized by fertilizer users still were higher than for nonfertilizer users (3803 vs 1707 PHP/ha).

Although almost all operators claimed that they practiced pest and predator control measures such as catch-and-kill or draining and drying of ponds, 73% still used chemicals. Users of chemicals realized higher yield and 29% higher receipts than nonusers. This meant a higher net income than that of nonusers (3786 vs 3105 PHP/ha) despite the added expense of chemicals (2238 PHP/ha, Table 2).

Those using fertilizer and eradicating pests with chemicals realized the highest gross receipts (6565 PHP/ha). This was followed by those practicing fertilization, pest eradication, and supplementary feeding (5712 PHP/ha). Thus, it appears that adding supplementary feed to fertilizer and chemical application in the pond resulted in lower gross income. This need not be so, however; perhaps those using fertilizer and chemicals have very fertile ponds, thus the applied fertilizer further enhanced the growth of natural food. In contrast, the other farms were probably of poor soil quality and therefore yielded lower levels of output, even after the use of supplementary feed: without it, the yield might have been even lower.

In terms of expenditures incurred, those employing both fertilization and supplementary feeding reported the highest expenses (3231 PHP/ha) followed by those using fertilizers, chemicals, and supplementary feeds (2573 PHP/ha).

The high yield obtained by fertilizer-and-chemical users was translated into high net returns (4491 PHP/ha). Next came those using only fertilizers. It is somewhat surprising that those who did not use purchased inputs realized a higher net income (1631 PHP) than those practicing only supplementary feeding (1059 PHP). As indicated earlier, the latter have low yields, probably because of poor quality soils.

Lablab growing seems to have brought about higher productivity and consequently higher receipts (Table 2). However, the advantage over *lumut* was quite small, only about 120 PHP/ha. *Lumut* growers incurred higher expenses than combined *lumut* and *lablab* growers. The high production of *lablab* users was further enhanced by their low expenditures, resulting in a high net income. Users of a combination of fry and fingerlings as stocking materials received the highest farm receipts (7225 PHP/ha). However, after subtracting the expense incurred, they came second to the users of fry as stocking material (3988 vs 4554 PHP/ha, Table 2). Users of only fingerlings received the lowest net income (1446 PHP/ha).

Total farm receipts are, of course, directly related to farm size. Similarly, farm expenses increased with farm size and so did net income. On a per-hectare basis, however, no direct relationship was found between net income and farm size. There was, however, a tendency for small ponds to have a higher net income per hectare. The highest net income was generated by ponds smaller than 2 ha and the lowest by ponds between 10 and 20 ha in size (6231 vs 2260 PHP/ha, Table 2).

The larger number of rearings per year (four), which gave a yield of 1600 kg/ha, also gave the highest farm receipts (9078 PHP/ha, Table 2) and the highest net income (8082 PHP/ha), which clearly demonstrate more efficient pond utilization. Three, two, and one rearings per year form a descending order of profitability: one rearing per year gave a net income of only 958 PHP/ha per year.

Farm receipts, expenses, and net income were found to be directly related to stocking density (Table 2); the higher the density, the larger were the receipts, expenses, and net income. Although farm receipts per hectare from the lowest-stocked ponds were 17% of receipts from the most densely stocked, net income was only 8% reflecting the relatively high expenses, 38%.

Of the two stocking methods used, bulk stocking was more widely practiced, probably because it brings higher receipts than staggered stocking. Bulk stocking can take advantage of low fry prices. Farmers could stunt their fry and transfer them to rearing ponds later rather than purchasing fry every time it was needed. Despite its high costs as compared with staggered stocking, bulk stocking realized twice as high a net income (Table 2).

Production Function Analysis

To analyze the effect of various inputs in milkfish production, a production function was estimated using the survey data. Such a function is a relationship between output and inputs and can be expressed algebraically as:

$$Q = f(X_1, X_2, X_3, ..., X_n) \quad [1]$$

Where Q is a measure of output and Xs are quantities of inputs.

For the purpose of this study, the Cobb-Douglas functional form was used. Output was defined in terms of the total value of milkfish produced per farm. It was hypothesized that output was related to the following variables: operational farm area in hectares (X_1), amount of nitrogen fertilizer in kilograms (X_2), amount of potassium (K_2O) fertilizer in kilograms (X_3), value of pesticides used in pesos (X_4), quantity of seed stocked in thousand pieces (X_5), value of supplementary feed in pesos (X_6), operating expenses in pesos (X_7), capital investment in pesos (X_8), and value of hired labour (X_9). Two dummy variables were also included for type of pond layout: D_1 (= 1) for one-level pond layout (zero otherwise) and D_2 (= 1) for two-level pond layout (zero otherwise). A further dummy variable (D_3) was added for pond ownership (D_3 = 1 for privately leased farms, zero otherwise).

The production function therefore was defined as:

$$lnQ = a_0 + \sum_{i=1}^{9} b_i lnX_i + \sum_{j=1}^{3} c_j D_j + \mu \quad [2]$$

Where a_0, b_i, and c_j are regression coefficients to be estimated, and μ is an error term with appropriate properties.

Two types of production functions were estimated: first, where per-farm values were used and, second, where per-hectare values were used. The regression coefficients are presented in Table 4. In a Cobb-Douglas production function, these coefficients also represent the elasticities of production with respect to each of the inputs. To indicate the relative importance of each input, the standardized coefficients were also computed (Table 4).

The most important variable found to affect milkfish pond output was the stocking rate. If all other inputs remained at the same level, a 10% increase in the stocking rate would have brought about a 6.29% increase in output. The average stocking density of the farms amounted to 5.72 thousand pieces (at the geometric mean). Given the value of marginal products (VMP) at the geometric means of fry and fingerlings and their current prices, it is apparent that stocking rates are below their profit-maximizing levels.

The fertilizer elasticity of production was 0.065, which implies that a 10% increase in fertilizer input would expand production by only 0.65%. The VMP of this input was estimated at 16.91, which is much higher than the price of nitrogen fertilizer at 3.25 PHP/kg (warehouse price of fertilizer). Such a large gap implies that milkfish operators could further increase pond productivity and profit by increasing the quantity of fertilizer applied.

The same conclusion can be made for capital

Table 4. Estimated regression coefficients[a] of milkfish production function, Philippines, 1978-79.

Variable	Per farm		Per hectare	
	Regression coefficient	Standardized coefficient	Regression coefficient	Standardized coefficient
Constant	7.046	–	6.065	–
Farm area (X_1)	0.080*	0.081	–	–
Nitrogen fertilizer (X_2)	0.065**	0.171	0.097***	0.179
Potassium fertilizer (X_3)	–	–	–0.080***	–0.169
Pesticides (X_4)	0.027*	0.118	–	–
Stock (X_5)	0.629***	0.683	0.698***	0.643
Supplementary feeds (X_6)	–0.034	–0.137	0.054**	0.122
Operating expenses (X_7)	–	–	0.134	0.123
Capital investment (X_8)	0.037*	0.077	–	–
Hired labour (X_9)	0.035**	0.177	–	–
One-level pond layout (D_1)	–0.395	–	–	–
Two-level pond layout (D_2)	0.100	–	0.248***	–
Privately leased farms (D_3)	–0.167	–	–	–
R^2	0.831	–	0.686	–

[a]Asterisks indicate significance at 1% (***), 5% (**), and 20% (*) levels.

investment and operating cost, that is, these inputs should be increased to achieve larger net returns. On the other hand, the optimum area was smaller than the actual area operated by milkfish pond operators. This is consistent with previous findings by Librero (1979) that fish farms in the Philippines are not fully utilized.

For supplementary feeds, the coefficient was negative. It should be recalled that fish pond productivity declined when supplementary feeds were added to fertilizer and chemicals.

The production function analysis indicates that milkfish farms in the Philippines are underutilized. On the average, the area is large whereas the levels of other inputs such as fertilizer, stock, and operating capital are relatively low.

Summary and Policy Implications

From a survey of 197 fish ponds throughout the country (of which only 193 reported), this paper attempted to analyze the economics of fish-pond production, particularly the aspects of production, technology, and costs and returns.

Almost 78% of the fish ponds studied were no more than 10 ha in area and more than half were under 5 ha. Most of these fish ponds were privately owned and acquired through purchase or inheritance.

The technology used in fish ponds was classified according to the combination of fertilization, pest eradication by chemicals, and supplementary feeding used. Nationally, the practice of fertilization and pest eradication with chemicals was the most widely used. Monoculture ponds supplied with fertilizer and pesticides gave the highest yield followed by those which were supplied with fertilizer, pesticides, and supplementary feeds (1194 and 1068 kg/ha). Nonapplication of all the three inputs resulted in the lowest productivity (520 kg/ha) among the technology groups. In contrast, under polyculture, the yield was highest (2244 kg/ha) for farms applying only fertilizer followed by those that combined fertilization and supplementary feeding; however, the sample was too small for statistically valid tests.

Production per hectare increased as stocking rates became higher for both bulk and staggered stocking. Land efficiency per unit area was greater for smaller ponds. Under monoculture, areas of less than 2 ha and 5–10 ha produced the highest yield (1300 kg/ha). Under polyculture, farms of 5–10 ha gave the highest production (1450 kg/ha).

Farms under polyculture realized higher receipts than those under monoculture. Likewise, polyculture farms incurred higher expenditures but realized a higher annual net income than monoculture farms (4580 vs 3360 PHP/ha).

Farm receipts, expenses, and net income increased with farm size. Per-hectare, however, farms in the smallest size category (less than 2 ha) realized the highest income (6731 PHP/ha).

Evidence shows that the application of the right quantity of inputs, especially fertilizers, chemicals, and stocks, would result in increased productivity in fish ponds. A production function analysis of the fish ponds showed that inputs such as fertilizer, fry or fingerlings, and operating capital are applied at less than optimum level: the VMP was higher than the prices of these inputs. This implies that the efficiency of farms could still be improved and profits could be raised by increasing the use of these inputs.

Present production methods underutilize the existing milkfish ponds. With the limited mangrove areas now available, this conclusion points to the need for more intensive utilization of existing fish ponds rather than expanding the area in pursuing the government's target for increased milkfish production. Intensification of existing ponds is in line with government effort to conserve the mangrove areas. However, pond intensification requires some form of government assistance to fish farmers who are facing capital and technological constraints. In this context, it is appropriate to examine the scope for and cost effectiveness of policies such as input price subsidies, credit, and extension of improved culture technology.

Economics of Coastal Aquaculture in Peninsular Malaysia

Ishak Haji Omar

Government efforts to improve the welfare of small-scale fishermen, in the form of subsidies for boats, nets, or engines, have the undesirable long-term effect of increasing fishing intensity and creating a stress on the limited fishery resource base. The inability of capture fisheries to meet domestic needs has generated considerable interest in culture fisheries in Malaysia. With diminishing marine landings on the West Coast of Peninsular Malaysia and a limited resource base on the East Coast, policymakers are formulating plans for aquaculture development. Coastal aquaculture holds a great potential as a source of both additional fish supplies for consumers and income and employment for coastal fishermen, both of whom are currently affected by dwindling natural fishery resources.

However, information on coastal aquaculture systems to guide investment planning effectively in such ventures is lacking, or is, at best, fragmentary. This study explores the existing coastal aquaculture practices and generates information suggesting that such systems are viable and can provide a new component in the government's overall strategy for small-scale fisheries development.

Methodology

The study was based on a survey of fish farmers conducted in all states of Peninsular Malaysia. Respondents were identified through the collaboration of the Fisheries Department and the Fisheries Development Authority Malaysia (Majuikan). Because of the limited number of fish farmers, the whole identifiable population of 80 was interviewed.

The coastal aquaculture systems used in Malaysia are on-bottom culture, which is confined to cockles cultivated in mud flats; marine (aquatic) suspended culture, in which fish and mollusks are cultured in suspended rafts or cages; and pond or embankment culture, in which ponds or embankments are constructed in cleared mangrove swamps for the culture of finfish, crabs, and prawns.

Information was solicited directly using a questionnaire designed to ensure that information gathered was accurate and adequate for the analysis. The questionnaire contained questions on the background of the farmers and their families and was followed by questions on size of investment, ecological characteristics, culture practices, yields, and marketing outlets, as well as cross-check questions.

Several analytical tools were employed because not all ventures could be similarly assessed as they differed in cost components, culture practices, and regularity of returns. In the subsequent viability analysis of the culture systems, a scale of operation of one person was considered. This is consistent with the overall objective of the study, i.e., the assessment of coastal aquaculture as an instrument of small-scale fisheries development.

Some of the limitations of the study must be acknowledged, however. First, with a limited number of respondents, the information gathered, particularly for the viability analysis, was biased toward the better organized farms because these farms generated more reliable information. Second, the research only focused on existing coastal aquaculture practices and neglected other resource-use options in the coastal zone or the environmental effects of coastal aquaculture on the coastal ecosystem.

In fish farming, several variables are likely to influence the overall performance of a culture system: for example, management practices, size of enterprise, site characteristics, production techniques, and locational differences in input prices and marketing outlets. However, given the diversity of culture systems and of their scales of operation, it is difficult to consider all these variables simultaneously. Instead, the economic evaluation here is limited to analyzing the field data collected.

A scrutiny of the fixed costs reveals significant differences in the establishment costs of culture systems. For cockle (*Anadara granosa*), establishment costs are almost zero, because culture is dependent upon naturally occurring mud flats; however, for mussel (*Mytilus viridis*), costs are almost wholly fixed because rafts are the only requirement. For cage culture of finfish, establishment costs depend upon the scale of operation; for example, a system of more than eight cages necessitates the construction of a floating house for efficient maintenance and management. However, because this study is oriented toward the small-scale operator, it includes operations having up to four floating cages only. Computation of the establishment costs of a 1-acre pond (0.40 ha) is made difficult by differences in site topography, year of construction, and locational differences in input prices. For comparability and assessment of the relative profitability of mangrove-based activities, an "unbiased" estimate of the costs of a 1-acre pond was made and used uniformly for all practices. "Unbiased" here implies an objective assessment of the current costs of construction of a 1-acre pond based on the estimates provided by a number of contractors.

Operating Costs

Operating costs vary with input levels in any production period. Each production or culture system has its own set of inputs with differences in input requirements, such as fry, feed, labour, and maintenance operations. Although operating costs of all culture systems are assumed to be constant for the period under study, significant changes in operating costs that may affect the viability of the culture systems over time are given due consideration through the use of sensitivity analysis.

In addition to the operating costs, the opportunity costs for the use of land (or sea space), labour, and capital are considered in the overall assessment of the culture system. To facilitate the analysis, the following assumptions were made:

- The operating cost of the operator is based on the going wage rate for one permanent worker.
- The culture site is treated as having zero opportunity costs. Because the sites are located in coastal swamplands or fringe waterways, they have little alternative use and, even if operators have to pay a government fee, the charge is negligible — 12–22 MYR/acre (2.19 ringgit [MYR] = US$1).
- The discount rate chosen is 20%, which is about 10% above the market rate, to cover the risk factor because coastal aquaculture is a high-risk investment and funds are difficult to obtain from credit institutions. Survey observations showed that some coastal aquaculture projects had to be abandoned because of damage from storms, underwater currents, excessive fouling, and sudden intrusions of inland fresh water or industrial pollution.

Economic Evaluation

With this economic rationale and the physical information gathered from the survey, cost and return statements for each venture were computed on an annual basis (Table 1).

All culture systems appear to be viable because total investments can be recovered by the end of the 2nd year.[1] For cockles and finfish cage culture, profits are realized from the first harvest. In fact, both ventures are so profitable that only 11.5% of total cockle harvest and 13.7% for finfish in cage culture are needed for the projects to break even. For pond systems, which have high establishment costs, finfish culture and crab-fattening ventures realize profits in the 2nd year but prawn culture does not do so until the 3rd year.

Cash flow statements were developed from cost and return data to project future income and expediture streams for each system. Financial analysis using discounted net present value (NPV), benefit: cost ratios, and internal rate of return (IRR) criteria were then applied to determine the relative profitability of the projects (Table 2).

Results indicate that, for all criteria, the culture practices studied are very profitable. Benefit: cost and IRR criteria were used to rank the culture systems and, as expected, cockle culture generated the highest rate of return.

[1] Even though all culture systems generated lucrative returns, the adoption or expansion of the ventures by the public has been limited for several reasons. First, information on culture practices is lacking or is too fragmentary to provide any meaningful guide to potential investors. Second, barriers to entry into such ventures exist because operators regard their management techniques as occupational secrets. Lastly, interested parties are often deterred by the high initial costs of investment and the difficulties that arise in trying to secure loans from credit institutions, which are usually uninformed on such ventures.

Table 1. Annual costs and returns (in MYR)[a] of coastal aquaculture systems for small-scale operators, Peninsular Malaysia, 1979.

Activity	Size of operation	Establishment costs	Operational costs	Total investment	Gross return
On-bottom culture					
Cockles	1 acre[b]	600	8778	9378	14000
Suspended system[c]					
Finfish *(kerapu)*	4 cages	1127	6143	7270	8800
Mussel	1 raft	2100	2250[d]	4650	3808
Pond system					
Finfish[e]	1 acre	15300	7535	22835	16658
Prawn	1 acre	15300	9566	24866	16500
Crabs	1 acre	16200	23478	39678	36450

[a]US$1 = 2.19 ringgits (MYR).
[b]1 acre = 0.405 ha.
[c]Suspended systems were assumed to have a life span of 4 years.
[d]The high operation cost of mussel culture are due to the opportunity cost of labour, which accounts for 71% of the total variable costs.
[e]These are average figures for the three species cultured in the pond system: *ketutu (Oxyeleotris marmoratus), kerapu (Epiniphelus pachycentron),* and *siakap (Lates calcarifer).*

Table 2. Financial analysis of coastal aquaculture systems, Peninsular Malaysia, 1979.

Activity	Net present value (MYR)[a]	Benefit: cost ratio	Internal rate of return (%)
On-bottom culture			
Cockles	4630	1.49	>100
Suspended systems			
Finfish	5899	1.35	> 90
Mussel	1233	1.14	49
Pond system			
Finfish	24749	1.35	64
Prawn	15654	1.30	49
Crabs	39632	1.35	85

[a]US$1 = 2.19 ringgits (MYR).

Table 3. Sensitivity analysis (% decrease in net present value) of coastal aquaculture systems, Peninsular Malaysia, 1979.

Activity	Decrease in output price (20%)	Increase in feed costs (20%)	Increase in costs of fry (20%)
On-bottom culture			
Cockles	60.5	na[a]	8.6
Suspended system			
Finfish *(kerapu)*	77.0	11.4	14.7
Mussels	60.0	na[a]	na[a]
Pond system			
Finfish	77.0	11.5	14.7
Prawns	88.0	30.0	3.8
Crabs	77.0	4.9	33.0

[a]Costs do not exist for these items in these systems; therefore, net present values are unchanged.

Nonetheless, the other culture systems were also very lucrative as compared to returns from alternative investments. Studies have shown, for instance, that the IRR on investment in rubber can range from as low as 3.5 up to 22.8%; for palm oil, from 4.3 to 29.4%; and for trawler fisheries, it is about 18.2% (Khalilunnisha 1979). Thus, with IRR rates of greater than 45%, coastal aquaculture investments compare very favourably with any agriculture-sector investment.

The estimates of the relative rates of return of the aquaculture system will hold true if assumptions made earlier hold in the future. However, because of the high degree of uncertainty, particularly with regard to future input and output prices, the findings were subjected to sensitivity analysis by varying three key assumptions — output prices, feed prices, and cost of fry. These variables were considered separately, with output prices being decreased 20% and the two cost items being increased 20%. Other variables were of lesser importance and therefore ignored — for example, output variation was not considered because mortality rates of culture systems are low and unlikely to cause drastic changes in output levels.

For all the culture systems, the sensitivity analysis showed that NPVs were still positive, i.e., decreases were less than 100% indicating that all culture systems were still viable even after adverse changes in the key variables (Table 3). Despite the differences in the cost composition of different culture practices, the viability of all systems is most susceptible to a drop in output prices, as one would expect. With respect to the remaining two variables, the culture systems (with the exception of prawn culture) are more sensitive to changes in costs of fry than of feed. Given these findings, it is imperative that any major effort at coastal aquaculture development be equipped with a parallel marketing strategy to achieve, if not improve upon, the expected output prices so as to ensure the viability of the project.

Conclusion

From this preliminary study of the viability of coastal aquaculture systems in Peninsular Malaysia, considerable scope apparently exists for the expansion of this form of fishery to enhance fish production and bridge any shortages of edible fish from marine landings. Policy measures for the development of small-scale fisheries should integrate coastal aquaculture with capture fisheries to provide an avenue for greater intensity of labour use, thereby generating higher incomes to the fishing community.

However, coastal aquaculture has constraints to contend with as well. The lack of support facilities, as well as of technical expertise for site identification, fry production, and improvement in culture techniques, currently limit the expansion of coastal aquaculture activities. Of these, proper site selection appears to be the most crucial factor in determining the success of all culture systems. Because such systems are susceptible to both natural and artificial hazards, the need for proper site selection is obvious. Suitable locations for these culture systems should be mapped on a national basis to reduce the risks in such ventures and ensure fuller utilization of coastal resources.

The cost structure of aquaculture farms requires a substantial capital outlay for the initial establishment of most culture systems. At present, credit institutions are unaware of these culture practices and are unwilling to extend loans to potential investors. For the small-scale fishermen who often struggle for a living and are "starved" of capital, some form of credit arrangements must be formulated so that participation from the target group can become a reality.

The results of the financial analysis indicate that, in terms of several profit criteria, the returns to investment in aquaculture projects were very high. For each of the culture systems under study, the computed IRR was over 45%, which is more favourable than any agricultural-sector investment. Results of the sensitivity analysis add further weight to the evidence of the profitability of coastal aquaculture. Even with a 20% increase in costs of feed and fry, or a 20% drop in output prices, all systems still yielded positive NPVs. The sensitivity analysis further revealed that output prices were most crucial to the overall viability of the culture systems. It is imperative, therefore, that any major effort to develop coastal aquaculture must be accompanied by a parallel marketing strategy to achieve, if not improve, the expected output prices so as to ensure project viability.

From the analysis, it can be concluded that coastal aquaculture is suitable on a small scale. However, the ultimate success of such ventures in the development of the small-scale fishery sector depends upon the government, which determines the policies and provides the incentives for such development. To this end, Majuikan and the Fisheries Department must combine efforts and work more cohesively so that success can be achieved on a planned and sustained basis.

Freshwater Fish Culture in Peninsular Malaysia

Mohd. Sheffie Bakar

Until very recently, the development of freshwater fish farming has been neglected by the government and trends in the development of the Malaysian fishing industry have been biased toward exploiting marine resources. However, freshwater fish culture is an additional means to achieve the government's goal of eradicating rural poverty.

The success of pioneering operations in freshwater fish culture in the region based on recent advances in aquaculture techniques has prompted a policy of promoting freshwater fish culture on small farms as a source of food and additional income. This policy should help reduce the widening gap between the demand for and supply of fish — the country's main source of animal protein — and thus keep it within the reach of low-income groups.

The Problem

The cultivation of freshwater fish in Malaysia is mainly confined to two types of water bodies, unused mining pools and excavated ponds. Freshwater fish culture is also found in such other water bodies as rice fields, rivers, irrigation channels, and natural lakes; however, their production is insignificant.

Fish are cultivated in excavated ponds and unused mining pools by fish farmers working either part time or full time, mainly on a commercial scale. Because such ponds and mining pools differ in size and have different stocking rates and maintenance needs, it is appropriate to study the structure of their costs and returns separately and comparatively.

The basic objective of this study is to estimate the economic potential of freshwater fish culture in the excavated ponds and unused mining pools through a study of their costs and revenue profiles. Policy implications based on the analysis will also be drawn.

Methodology

A sample of 150 fish farmers operating excavated ponds and unused mining pools was selected with the cooperation of the Ministry of Agriculture and the Fisheries Development Authority (Majuikan). Of this sample, 84% were farmers operating excavated ponds and the balance operated unused mining pools. Care was taken to select farmers in the vicinity of marine fishing settlements to establish whether there was occupational mobility between capture and culture fisheries.

Framework of analysis

Because only the short-run period is considered, the concepts of fixed and variable costs of freshwater aquaculture projects are used. Fixed costs consist of depreciation of farm implements and buildings, pond amortization costs, and interest on capital. Variable costs include costs of current supplies such as fish fry, fertilizers (chemical and animal manure), insecticides and pesticides, and costs of family and hired labour employed on fish farms.

The following assumptions were made:

- Although depreciation due to obsolescence of machinery and buildings should be included in fixed costs, and expenditures on repairs and replacements, which vary with the use of buildings and equipment, should be included in variable costs, all such costs were treated as fixed because of the difficulty of separating them (see Ong 1980).
- 10% of the construction costs were applied as amortization costs based on the assumption that the life span for a fish pond is about 10 years.
- An annual interest rate of 10% (equivalent to commercial rates) was applied on the book value of fixed and working capital.

In farm-management analysis, production costs can be classified into expenses for purchased inputs and farm-family inputs. The costs of purchased inputs are included under farm expenses, but production costs related to farm-owned inputs are included under farm income.

Items that were included in farm expenses were

- Costs of chemical fertilizers, insecticides and pesticides, fish feed, fish fry, and other materials;
- Wages paid to hired labour;
- Repair costs and depreciation charges on farm implements and buildings;
- Taxes and miscellaneous charges; and
- Interest paid on borrowed capital.

The items included in production costs but excluded from expenses were

- Cost of family labour;
- Market value equivalent of manure and vegetables used as fish feed; and
- Interest on fixed working capital.

Costs and returns were estimated on the basis of two sizes of excavated ponds — 0.25 and 0.50 acre (0.1 and 0.2 ha) — and two sizes of unused mining pools — 1.0 and 2.0 acre (0.4 and 0.8 ha).

Production Costs and Returns to Aquaculture Projects

Excavated ponds

In general, production costs[1] differed not only according to pond size but also according to type of pond and were higher on a per-acre basis for excavated ponds than for unused mining pools. The difference can be attributed solely to the zero construction costs of the latter.

Most of the farmers practice polyculture. The most popular species cultured include grass carp (*Tenopharyngodon iddelus*), common carp (*Cyprinus carpio*), big head carp (*Aristichxnys nobilis*), and Indonesian carp or *lampam jawa* (*Puntius gonionotus*).

In excavated ponds, total production costs for 0.2 acre and 0.50 acre ponds were estimated as 1103 and 1630 MYR (2.19 ringgits [MYR] = US$1) respectively (Table 1). Despite scale differences, the percentage composition of total cost varied by less than 2 percentage points for all items considered. The major cost items, family labour and fry, together constituted 50% of the total operational costs.

Profit was derived by subtracting total production costs, including costs of farm-owned productive factors, from total revenue. Income was obtained by subtracting costs of productive factors provided by others from total revenue. This income includes costs attributable to family-owned inputs and profits.

Profit rates for excavated ponds were positive for both sizes (Table 2). The profit rates were estimated at 12% for a 0.25-acre pond and 17% for a 0.50-acre. Income from 0.25-acre ponds was 5.7 times higher than profits, whereas for

[1]Details of these production costs are available in the comprehensive national report, which is available from the author.

Table 1. Distribution (%) of production costs of aquaculture according to farm size, Malaysia, 1979.

Item	Excavated ponds		Unused mining pools	
	0.25-acre	0.5-acre	1.0-acre	2.0-acre
Fry	20	21	26	41
Feed	5	5	9	7
Fertilizer	10	10	12	11
Chemical	2	2	2	2
Manure	8	8	10	9
Insect and disease control	3	2	2	3
Materials	4	3	0	4
Labour	32	32	30	22
Family	31	30	23	18
Hired	2	2	6	4
Pond amortization costs	14	15	4	3
Farm implements	3	3	1	1
Liming	2	2	5	4
Depreciation	<1	<1	<1	<1
Taxes and other charges	<1	<1	<1	<1
Interest on capital	7	7	<1	<1
Total costs (MYR)[a]	1103	1636	1625	2372

[a]2.19 ringgits (MYR) = US$1.

Table 2. Total revenue, production costs, farm expenses, and profits (MYR)[a] of aquaculture according to project sizes, Malaysia, 1979.

	Excavated ponds[b]				Disused mining pools[c]			
	Per farm		Per kati[d]		Per farm		Per kati	
	0.25-acre	0.50-acre	0.25-acre	0.50-acre	1.0-acre	2.0-acre	1-acre	2-acre
Total revenue	1233	1921	1.80	1.80	3672	8424	1.80	1.80
Production costs	1103	1636	1.61	1.53	1625	2372	0.80	0.50
Profit	130	285	0.19	0.27	2047	6052	1.00	1.30
Farm expenses	487	701	0.71	0.66	955	1490	0.47	0.31
Income	746	1220	1.09	1.14	2717	6974	1.33	1.49
Profit to production cost ratio (%)	12	17	12	18	125	255	125	255
Income to production cost ratio (%)	68	75	68	75	167	294	166	294
Income to farm expense ratio (%)	153	174	154	173	285	481	283	481

[a] 2.19 ringgits (MYR) = US$1.
[b] Based on production of 685 katies from the 0.25-acre farm and 1067 katies from the 0.50-acre farm.
[c] Production was estimated by the following formula: Quantity of fish = fry stocked × survival rate × average weight. The number of fry stocked in 1.0-acre and 2.0-acre ponds were about 850 and 1950, respectively. The mortality rate was estimated as 20% and the average weight of fish as 3 katies.
[d] 1 kati = 0.5032 kg; fish were sold at an average price of 1.80 MYR.

0.50-acre ponds it was 4.3 times higher than profits. The rates of return to production costs for 0.25-acre and 0.50-acre ponds were about 68% and 75% respectively; or returns of 0.68 and 0.75 MYR for every 1 MYR invested, inclusive of the opportunity cost of capital.

The authorities have increased their efforts to expand this industry and increased budget allocations. However, progress is still quite slow because of physical as well as sociological reasons.

Unused mining pools

In 1979, the total production costs for 1.0-acre and 2.0-acre unused mining ponds were 1625 and 2372 MYR respectively, the difference being largely due to the higher stocking requirements in the larger ponds (Table 1).

Operating cost components for freshwater fish culture in unused mining pools were similar to those for excavated ponds in that the major cost items were labour and fry. The profit rate was positive and fairly high for both pond sizes, being 125% and 255% for the 1.0-acre and 2.0-acre ponds, respectively. The rate of return for a 2.0-acre pond is about 2.94 MYR for 1 MYR of outlay inclusive of the opportunity cost of capital.

The higher profit rate for aquaculture in unused mining pools than for excavated ponds is due to the zero construction costs in setting up the ponds and to their larger size. Higher stocking densities than are used now would increase the potential for larger harvests. Such ponds can be stocked with as many as 2000–3000 fish fry but many unused mining pools examined in this study had relatively low stocking rates.

Policy Implications

The study shows that aquaculture in unused mining pools is more profitable than in excavated ponds. However, expansion of freshwater fish culture through the use of unused mining pools has not taken place for two main reasons. First, the original policy to promote freshwater fish culture aimed at eradicating rural poverty. However, development of freshwater fish culture has been confined to the 0.25-acre and 0.5-acre excavated ponds normally located close to the operators' homes and on their own land, thereby eliminating the problems of ownership and tenurial arrangements. Second, most of the unused mining pools are still under lease to the mining companies, which are reluctant to give up their rights to remine them and this creates uncertainty of tenure for potential aquaculture. It is envisaged that, in the near future, the authorities will seriously consider expanding freshwater fish culture in unused mining pools. There is also considerable scope for the expansion of freshwater fish culture in excavated ponds provided the physical and social problems that have slowed their development are properly identified and solved.

Culture Fisheries of Bangladesh: The Issue of Unused Ponds

M. Sekandar Khan

When listing the resources of Bangladesh and grouping them according to degree of use or nonuse, tanks and ponds appear in the category of "wasted" resources. Damont (1973) has quoted a Ministry of Local Government, Rural Development and Cooperatives report giving a figure of 633 000 acres (256 000 ha) of tanks and ponds in Bangladesh of which nearly 75% are derelict. These derelict water bodies are not being used at all and, although potentially useable for fish culture, they require extensive reclamation. The balance of pond area may be treated as readily available for fish culture. This is reported to be 171 612 acres (69 450 ha) distributed into 523 500 tanks and ponds (Bangladesh, Bureau of Statistics 1979b). These ponds are scattered almost uniformly over the country with a few districts having a relatively high density. Pond size varies from a "very large" of 10 acres to a "small" of less than 0.10 acres (4–0.04 ha) but the average for Bangladesh is 0.30 acres (0.12 ha). Irrespective of location or size, these ponds are seldom used for production of fish. This is a curious situation considering the acute scarcity of land, the general protein deficiency of the masses, the lack of adequate employment opportunities, and the general condition of poverty in Bangladesh.

The consumption of fish, the main source of animal protein, is recorded in a joint FAO- UNDP Agriculture Mission report (FAO 1977) as being far below the normal nutritional level. Throughout the 1960s and 1970s, fish consumption decreased and now is 22 g/day per person against the estimated minimum requirement of 73 g, assuming, as the planners do, that 80% of the animal protein is contributed by fish (Bangladesh, Planning Commission 1980).

Unemployment is widespread in Bangladesh. The level of employment has been estimated to have declined from 34% in 1961 to 28% of the total population in 1980 (Bangladesh, Planning Commission 1980). The situation is growing worse in the rural sector where one projection estimates that unemployment will grow at a rate of about 2–3% per year in this decade (Clay and Khan 1977). Poverty remains a widespread problem of the masses. Vigorous attempts to increase the sources of income have led to a greater utilization of known resources. Fish ponds are yet to contribute their potential as a supplementary source of employment and income.

The role of ponds is also important for a host of other reasons of which the following are the more obvious ones. First, ponds are a readily available asset for exploitation. In the villages, ponds are dug and maintained for other reasons and their exploitation for fish culture requires little extra effort. This makes the social profitability of pond aquaculture potentially high. Second, because ponds are scattered all over the country with a higher density in the countryside, production of fish in them would provide protein supply in the interior without extra effort for distribution. It will, therefore, represent an efficient and equitable source of protein and food. Third, in a situation of depleted natural fish stocks in the overexploited inland riverine waters and inadequate capacity to exploit the marine fishery resources, the importance of pond fishery becomes obvious.

It is, therefore, paradoxical to find thousands of ponds lying unused while all indicators point to the need and social profitability of their utilization for fish production.

The main purpose of this study is to investigate the present state of fish culture and to attempt to answer why ponds are not utilized for fish production. First, the issues and hypotheses are discussed and the data and methodology described. Costs and returns of fish culture in ponds are analyzed and a profit function developed. Then the features characteristic of cultured and noncultured ponds and of their owners are compared and a production and investment function developed. The results are then summarized and policy implications noted, suggesting ways to increase and improve pond utilization for fish production.

Issues and Hypotheses

A number of factors may be responsible for the existence of large numbers of unused ponds alongside a few utilized ponds in the villages of Bangladesh. Our aquaintance with the owners in the study villages has convinced us that these owners do not differ in their knowledge of technology. It is therefore argued, a priori, that private profitability of fish production in ponds is the primary factor in determining their utilization. A study of the costs and revenue of fish production has, however, shown that this hypothesis is not tenable. Atiqur Rahman (1981) has shown that the profitability criterion is "unimportant" in explaining the relative rates of adoption of new technology in rice production in Bangladesh.

It is therefore argued that profitability alone may not be a sufficient criterion for utilization of ponds. A host of other factors relating to both the ponds and their owners may be responsible for the existence of a large number of unused ponds alongside some utilized ponds in any given village. It is possible to make a list of such factors and their expected influence on pond utilization may be hypothesized. The relevant factors relating to ponds are type of ownership, size and age of ponds, hazards of fish culture, and the purpose for owning ponds. In addition, several factors relate to pond owners: awareness, residence, age, whether agriculture is their main occupation, presence of a secondary occupation, educational level, ratio of total size of family to earning members, and annual family income.

It is possible that, even though fish production may be profitable, ponds are not utilized because of multiple ownership, which has been identified as an obstacle to pond aquaculture (FAO 1977). Smith (1973) pointed out that it is not unusual for tanks to be fragmented in the same way as plots of agricultural land and that it becomes difficult to obtain agreement from the many owners on use of a pond. Because ponds cannot be subdivided like agricultural land, such lack of agreement may lead to disuse of ponds for productive purposes. Often, one of the owners of jointly owned ponds leaves the village to live elsewhere in pursuit of employment and loses interest in developing the pond or tank for fish culture. The coowner of the property residing in the village is, in such cases, usually hesitant to invest money for culturing fish in these water areas for fear that the absentee coowner of the property would claim his legal right to a part of the derived profits. It is quite common to find a pond being owned by a number of owners with unequal shares. Again, the different coowners may also be unequal in their economic status. In such cases, those with smaller shares or who are poorer (but may own a large share of the pond) tend to be less interested in investing in fish culture but keener in claiming their share of the output. The larger and the richer coowners in such a situation are also discouraged from investing. Thus, multiple ownership may deter utilization of ponds for fish culture.

Another factor that may influence pond utilization is the size of the pond. Large ponds, over 1 acre (0.4 ha) in area, are more suitable for the culture of Indian carp, the only species stocked in most ponds of Bangladesh (Shafi et al. 1977). Small ponds are less suitable for fish production. Therefore, small size of ponds may be one cause of nonuse.

Age of the pond may be another factor influencing its utilization. Old ponds are less likely to remain suitable for fish culture because they may have become physically derelict through lack of maintenance. Old ponds that are not well maintained become silted and thus unsuitable for growth of carp, which ideally require water that is 6–8 feet (1.8–2.4 m) deep (Shafi et al. 1977). Again, ownership of such ponds may have been divided and subdivided through sharing among descendants of the original owner to the point of making the coowners uninterested in their utilization.

Fish production may be hazardous. These hazards include flooding of ponds, risk of theft, and the problem of predators. Such hazards may also discourage investment in pond aquaculture.

Further, ponds are dug for a variety of purposes: for mud to be used in the construction of house mounds or for water for washing, bathing, and drinking (Khan 1979). Such ponds are also used for fish culture, which may, over time, become an important use in some cases. However, wherever the primary purpose remains something other than fish production, they are more likely to remain unused for fish culture.

Utilization of ponds depends also on the socioeconomic conditions of their owners. The pond owners' awareness that it is profitable to utilize their pond for fish production is a necessary precondition for the pond to be utilized. Lack of such awareness may result in the pond being unused.

Pond owners may reside in the village or outside. It is difficult for a nonresident owner to utilize a pond for aquaculture because this requires close supervision and care of the pond and the stock. It is, therefore, possible that pond utilization may be absent in the case of absentee owners.

Age of owners is also important because aquaculture requires initiative and imagination on the part of the entrepreneur. These qualities are more likely to be found among younger owners, say of less than 40 years of age.

The main occupation of owners may influence their interest and ability to engage in aquaculture. It is expected that owners whose main occupation is agriculture will have closer ties with the village and, therefore, greater opportunity to engage in aquaculture. However, those who have a secondary occupation might be too busy to engage in pond fish culture.

The educational level of the pond owners is also important in determining their role in aquaculture. Greater education increases a person's opportunities for employment. Thus, more educated owners may have less opportunity, or need, to engage in fish production.

The ratio of family size to the number of income-earning members indicates the dependancy ratio in a family. If the number of dependants in the family is large, there is a greater likelihood that all assets of the family will be utilized. Thus, ponds belonging to families with low dependancy ratios may remain unutilized.

The annual income of the family may be another important determinant of pond utilization. If the annual income of the family is high, the pond owner will be less interested in aquaculture because he has already sufficient income and also because it is not considered socially "honourable" to have to supplement one's income through the sale of fish from one's pond.

To test these hypotheses, primary data were collected, costs and earnings were estimated, the characteristics of used and unused ponds and of their owners were compared, and profit, production, and investment relationships were estimated statistically.

Data and Methodology

The present study is based on data collected for a small-scale fisheries study of pond aquaculture in Bangladesh. These data have been generated from a survey of ponds of three villages — Dholipara in the Comilla District, and Brahmuttar and Fatehabad in the Chittagong District — over a period of about 2 years (1980-81).

Dholipara has a relatively long record of fish farming. Because of its proximity to Bangladesh Academy for Rural Development at Comilla, it has a tradition of putting all its resources to productive uses. It is also an advanced village in agricultural production. All ponds in this village are utilized for fish production. In the jointly owned ponds, aquaculture is managed by the senior owners of the group.

Brahmuttar has been recently organized into a self-reliant village and all ponds, like any other asset, are being put to productive uses. As a self-reliant village with a village government and members (ministers) in charge of all departments, this village also had a member to look after its fishery. He has organized a program for gradually putting all ponds to use for aquaculture. All owners of ponds also reported that they had either started or were preparing to start stocking their ponds.

Fatehabad is an ordinary village. No external factor has influenced resource use nor has any conscious effort for development been undertaken there.

For the present study, we have drawn mainly on the data from Fatehabad and Dholipara. In both villages, pond size and ownership vary widely. More than 40% of the sample ponds fall in size group 0.20-0.34 acres (0.08-0.14 ha) and nearly 70% of them are below 0.50 acres (0.2 ha) in size (Table 1). Although joint and single ownership of ponds was equal at Fatehabad,

Table 1. Distribution of ponds by size and ownership in Fatehabad and Dholipara, Bangladesh, 1980-81.

	Fatehabad	Dholipara	Total
Size			
< 0.20	7	0	7
0.20 - 0.34	12	24	36
0.35 - 0.49	6	8	14
0.50 - 0.64	0	5	5
> 0.65	13	3	16
Ownership			
Single	19	11	30
Joint[a]	19	29	48
Total	**38**	**40**	**78**

[a] Joint ownership of ponds is a common feature of pond ownership in Bangladesh where the law of inheritance operates to divide all properties of a household among sons and daughters after the parent's death.

over 70% of them had multiple owners at Dholipara.

In identifying the hypotheses for nonuse of ponds, we tried to argue on theoretical grounds about the influence of as many factors as could be identified. To test our hypothesis about profitability of fish culture, a cost-and-return analysis was attempted with data from Dholipara village and a profit function was estimated.

To test the hypotheses regarding the influence of factors pertaining to ponds or to their owners, independent tests have not been set. Instead, data from village Fatehabad were used to prepare separate tables showing the preponderance of the relevent factors in each type of pond and in their respective owner group. This provides empirical evidence of the association of different factors with the use or nonuse ponds and with the owners of the two types of pond. Next, the role of different factors (including those found relevant from the tabular presentation) in fish production and in investment in fish culture were analyzed. A production function analysis, mainly with factors relating to ponds, and an investment function analysis, mainly with those relating to pond owners, have been attempted. The results of these latter analyses have been mainly relied on in drawing conclusions.

Cost and Return Analysis

The analysis of costs and returns shows the economic aspects of fish culture and is important from the point of view of pond operators because it concerns the viability of pond fish culture. The common feature of ponds is that most have existed in the village for a long time and the construction costs have been long forgotten. It is, therefore, not unusual for different owners or sharers to quote different costs for ponds of the same size. To avoid using an arbitrary cost for pond construction, we have adopted the land value of the pond of a particular size, as distinct from its land value as paddy land or homestead land (Table 2). The land value of the pond site is quoted to represent a lower value than paddy land or homestead land in villages. For example, in the study village, pond land is valued at 50 000 BDT/acre and paddy land at 100 000 BDT/acre (15.15 takas [BDT] = US$1). To derive the annual cost of the pond to its owner, the annual interest value of an amount of cash equal to the value of the pond has been used. To this has been added an annual depreciation based on the information provided for items of expenditure on maintenance such as bunding (rebuilding embankments), cleaning, etc. Sometimes, a pond is found to remain for several years without any significant repair or maintenance expenditure. Such a pond is usually reexcavated after an interval. This reexcavation cost has been distributed over the years to arrive at a figure for maintenance. In pond culture, there are a few other items of capital costs, for example, spades and nets.

Fry and fingerlings represent the most important operating cost (Table 2) because pond

Table 2. Estimated capital and operating costs and revenue (BHT)[a] of Dholipara fish ponds, by size, Bangladesh, 1980-81.

	<0.35 acre	0.35–0.49 acre	0.50–0.64 acre
Total capital costs	**5788.59**	**5510.56**	**5603.82**
Fish pond	5000.00	5000.00	5000.00
Depreciation	601.54	368.90	445.00
Other capital items	187.05	141.66	158.82
Total operating costs	**2280.82**	**1900.18**	**1638.19**
Fry and fingerlings	1006.23	1066.16	870.44
Feed, fertilizer, and medicine	188.18	128.14	39.81
Wages	1086.41	705.88	727.94
Total costs	**8069.00**	**7410.74**	**7242.01**
Total revenues	**14324.00**	**8149.00**	**9909.00**
Revenue : Costs	1.78	1.10	1.37
Earnings of fixed assets	12043.00	6249.00	8271.00
Profitability (%)[b]	84.1	76.7	83.5
Profit rate (%)[c]	77.5	10.0	36.8

[a]15.15 takas (BHT) = US$1.
[b–c]These rather unusual measures of "profitability" are adopted from Sugito (1977) to facilitate comparison of our results with those of Southeast Asian studies: [b]Earnings of Fixed Assets divided by Total Revenues and multiplied by 100; and [c](Revenues minus Costs) divided by Costs and multiplied by 100.

owners must buy and stock the Indian carp fry. Stocking practices, however, still remain haphazard partly because of the extreme difficulty of distinguishing various species at fry size. Moreover, a suitable polyculture technique is yet to be developed (Bardach et al. 1972). The size of different species of fish stocked is not standardized either and all sizes from fry to juveniles (1 inch long) are used. Although some rough sample stocking rates of Indian carp exist at the research stations, the pond owners lack knowledge of them. The cost of fry varies with its price and stocking rate. With the rapid increase in fish culture in the country (and the opportunity for smuggling ouside), the price of fry has risen about 100 times over the last 10 years.

The cost of feed, fertilizer, medicine, and protection are considered together. Because the use of supplemental feed is not common in fish ponds and the use of fertilizer or medicine is also rare, this is a relatively small item in the total operating costs — less than 10%.

The third element of operating costs considered is the wage cost of labour. Ponds are generally owner-operated and, except for harvesting, it is hard to find any hired labour working in aquaculture. Therefore, the cost of labour contributed by the owner or members of the owner's family in fish farming or harvesting has been imputed.

Production of fish in these ponds is given by the amount of catch harvested in a given year. Because ponds are not pumped dry for harvesting and the operators allow a sizeable portion of fish stock to remain in the pond at any one time, depending on the size of ponds, it will be fallacious to assume that the rearing pond is exhausted at the end of the season or year like the nursery ponds for fry in Bangladesh or milkfish ponds in the Philippines. The catch of fish includes some large, older fish as well as the 1-year-old fish from the current year's stocking. Therefore, the actual length of the culture period varies from pond to pond. On average, carp in the study village were found to be harvested after 9 months when *catla*, *rohu*, and *mrigal* attained weights of 2, 1.5, and 1.5 lb respectively (0.9, 0.7, and 0.7 kg).

The prices of carp and, therefore, of other species are increasing over time. With the increase of population, demand has increased while overall supply has shrunk because of falling supply from other inland sources and the inability of the marine fisheries to fill the gap.

The estimated costs and revenues are shown separately for the three size groups of ponds; however, the median value of the return-cost ratio is 1.29. This is higher than that for cultivation of the high-yield rice variety 'Boro' in Bangladesh (Bangladesh, Ministry of Agriculture and Forestry 1979).

Profitability rates for milkfish culture in Taiwan, the Philippines, and in Java and Jepara in Indonesia have been calculated as 25, 46, 22, and 28% respectively (Sugito 1977). The profit rate of aquaculture in the excavated ponds in Malaysia is 12% for ponds of 0.25 acres and 17% for 0.5 acres (Bakar, this volume, p. 258). Thus aquaculture in Bangladesh is more profitable than aquaculture in Southeast Asia and more profitable than alternative land uses in Bangladesh, e.g., rice production.

Profit Function Analysis

A profit function analysis has been estimated using the data from 40 ponds of one village (Dholipara). The independent variables used are number of fingerlings stocked (SC), labour employed (LC), other capital (OC), size of pond (PS), age of pond (PA), period of time the pond has been under fish culture (CP), and a dummy variable for pattern of ownership (OD). The estimated profit function, with estimated t statistics in parentheses, is

$$\begin{aligned} \hat{\Pi} = 806.493 &+ \underset{(2.859)}{4.424SC} + \underset{(0.385)}{0.823LC} - \underset{(-2.114)}{1.554OC} \\ &+ \underset{(1.187)}{2497.895PS} + \underset{(0.261)}{7.972PA} + \underset{(0.073)}{3.071CP} \\ &+ \underset{(0.187)}{95.949OD} \end{aligned} \qquad [1]$$

$R^2 = 0.827$; F value = 9.914; df = 32

It is evident that the number of fingerlings stocked made a significant positive contribution to profit. It may seem unusual that "other capital" (all smaller items of equipment such as spades, nets, etc. owned by the pond operators) had a significant negative effect on profit. For jointly owned ponds, values of this variable were higher because equipment owned by all the share owners was added to represent other capital of such ponds. It should be noted that the "joint ownership" dummy had a high positive correlation with the "other capital" variable and the effect on profit of the joint ownership dummy may well have been collected by the "other capital" variable so that the estimated coefficient of the dummy variable is statistically insignificant in this regression, whereas joint ownership is found to have a significant negative effect on investment in the investment function analysis. The negative contribution of "other capital" to profit would conform with the negative effect of joint ownership on investment. Other variables included in this analysis have positive, but statistically insignificant, effects on profit.

Characteristics of Used and Nonused Ponds

In the study village, 11 of the 38 ponds were found to have been used for fish production. The most important distinguishing feature was the ownership pattern: 84% of the jointly owned ponds were not used for fish culture (Table 3). However, only 58% of the single-owner ponds remained idle and, of these, 9 out of 11 are old ponds (more than 15 years old) — a fact that is found to characterize unused ponds. Another way of looking into the ownership pattern and pond use is to examine the proportion of singly and jointly owned ponds: 73% of the used ponds have a single owner and 59% of the unused ponds are jointly owned. One reason for this is because of the sense of insecurity of tenure created by joint ownership: one joint owner is not willing to incur all the costs of using the pond for fish culture and then to reap only a fraction of the returns.

It is evident that most large ponds are left unutilized: the majority of them are, however, old ponds that have many coowners — both factors that appear to result in nonuse. Although 76% of old ponds are not used for fish production, nearly an equal percentage (60) of the new ponds are also left fallow; however, most of such ponds are jointly owned. The obvious implication is that old, jointly owned ponds are allowed to remain idle.

Wherever fish production is the primary purpose for owning ponds, as might be expected, they are used for fish production. Only in 2 of 29 ponds where fish production was a secondary purpose for ownership were ponds utilized. All ponds were dug for purposes other than for fish production but not all of them are now held for their original purpose. Yet, when such other purposes are still a primary purpose for holding ponds, they are seldom used for fish production.

On the basis of Table 3, we can also rank these characteristics according to the frequency of their presence in both used and unused ponds. The unused ponds are held primarily for nonproduction purposes, owned jointly by several owners, large, and old. In contrast, the used ponds are found to be owned primarily for fish culture and are individually owned.

From the association of different factors with both types of ponds, it becomes clear that the purpose of holding ponds, ownership, and age of ponds are important considerations in pond use. There was no significant difference between used and unused ponds in terms of owners' perceptions of hazards of fish culture in ponds.

Production Function Analysis and Price Efficiency

The factors included in the production function analysis with data from Dholipara are stocking rate (SR), size of pond (PS), experience of the pond operator (OE), ownership (OD),

Table 3. Distribution of utilized and nonutilized ponds by characteristic, Fatehabad, Bangladesh, 1980–81.

Characteristics of ponds	Utilized ponds Number	Utilized ponds %	Nonutilized ponds Number	Nonutilized ponds %	Total
Ownership of pond					
Single	8	42	11	58	19
Joint	3	16	16	84	19
Size of pond					
Large	8	26	23	74	31
Small	3	43	4	57	7
Age of pond					
New	5	38	8	62	13
Old	6	24	19	76	25
Hazards of fish production					
Hazard-free	5	29	12	71	17
Hazardous	6	29	15	71	21
Fish production as a purpose					
Primary	9	100	0	0	9
Secondary	2	7	27	93	29

and feed etc. (FC). Although the purpose for holding ponds could have been used as a dummy variable, the Dholipara data indicate that almost all operators hold ponds for fish production as the primary purpose. Age of ponds was again found to be of no importance because ponds are well maintained. Production of fish (Y), is measured in terms of maunds of weight (1 maund = 82 lb = 37.2 kg).

The estimated log-linear production function equation, with estimated *t* statistics in parentheses, is

$$
\begin{aligned}
lnY = 3.129 &+ \underset{(2.113)}{0.158 lnSR} + \underset{(4.352)}{0.599 lnPS} \\
&+ \underset{(0.303)}{0.034 lnOE} + \underset{(0.582)}{0.797 lnOD} \\
&- \underset{(-0.890)}{0.105 lnFC} \qquad [2]
\end{aligned}
$$

$R^2 = 0.64$; $S^2 = 0.112$; F value = 12.16; df = 39

Pond size has a significant positive contribution to output as does stocking rate. These results are what we would expect on theoretical grounds. However, experience, ownership, and use of feed or fertilizer do not significantly affect output. A similar production function analysis with data from all three study villages has also shown a highly significant contribution of pond size and stocking rate to output.

Price Efficiency Analysis

The results from the production function analysis may be used to make a price efficiency analysis of the fish-farming enterprise. Stocking rate, which is shown to have a significantly positive contribution to output and to profit, could be increased with advantage. The value of marginal productivity (VMP) of 1 BDT worth of fry has been estimated to be 3.20 BDT.[1] This is another way of saying that it is profitable to increase the degree of utilization (or intensity of use) of ponds that are already used.

Table 4. Distribution of owners of utilized and nonutilized ponds by socioeconomic characteristics, Dholipara, Bangladesh, 1980–81.

	Percentage of owners	
Characteristics	Utilized	Nonutilized
Awareness	100	100
Residence	100	100
Age < 40 years	45	30
Agriculture as main occupation	75	55
Presence of secondary occupation	25	0
Educational level ≥ Class V	50	85
Dependency ratio ≤ 5	45	85
Annual family income >20 000 BHT[a]	55	70

[a]15.15 takas (BHT) = US$1.

Characteristics of Pond Owners

That utilization of ponds for fish production is profitable is common knowledge in the village (Table 4) and all pond owners have confirmed that they are aware of the profitability of pond fish culture. All pond owners were resident members of the village that we studied. Thus, in respect of these two characteristics, the two owner groups did not differ.

A considerable difference is, however, observed in respect of other characteristics. High educational level and family income and low dependency ratios are found, as expected, in a relatively large proportion (above 70%) of owners of unused ponds. For utilized ponds, however, less than 50% of the owners had any of these characteristics. As expected, a relatively larger proportion of owners of utilized pond have agriculture as their main occupation; they are also, on the average, younger than the owners of unused ponds.

We can rank these characteristics according to their relative prevalence among the two groups of pond owners. The owners of utilized ponds are agriculturists by profession, have a high dependency ratio, and are young. In contrast, the owners of unused ponds generally have a low dependency ratio, high educational level, and high annual family income. This suggests that owners of unused ponds have higher opportunity costs than owners of used ponds, which might explain, at least partly, why unused ponds remain so despite their owners awareness of the profitability of fish culture.

Investment Function Analysis

On the basis of the study of characteristics of pond owners, we carried out an investment

[1]$MP_1 = \partial Y / \partial X_1$ or $MP_1 = \hat{B}_1(\hat{Y}/X_1)$

where $\hat{Y}$ is the estimated output at the arithmetic means of all inputs; MP_1 is the marginal product of fry; Y is the output; X_1 is the fry; and $\hat{B}_1$ is estimated output elasticity of fry. Price efficiency requires that $P_y MP_1 = P_1$ where P_y is the price of output. If $VMP_1 > P_1$, where $VMP_1 \equiv P_y MP_1$ as in our case above, the input of X_1 should be increased.

function analysis with data from Dholipara. It was hypothesized that family income (FI), dependency ratio (DR), age (A), education (E), occupation or profession (PD), and ownership status (OD) of the pond owner are expected to influence his investment in pond fish culture. Investment (I) is measured in terms of expenditure on all inputs, purchased or owned, except for the pond.

The estimated linear investment function, with estimated t statistics in parentheses, is:

$$
\begin{aligned}
I = 5294.89 &+ \underset{(2.066)}{0.046FI} - \underset{(-0.270)}{44.805DR} - \underset{(-0.856)}{17.900A} \\
&- \underset{(-1.186)}{687.220E} + \underset{(0.490)}{355.664PD} - \underset{(-4.126)}{3866.393OD} \quad [3]
\end{aligned}
$$

$R^2 = 0.270$; F value = 3.18; df = 68

It should be noted that the R^2 is low which means that little of the overall variation has been explained. However, with cross-sectional data, an R^2 value as low as this is not unusual. Moreover, the linear specification of an investment function dictated by our data should not be expected from a theoretical point of view to give a good fit. In any case, the above results indicate that family income has a significantly positive relationship to investment whereas joint ownership is unfavourable to investment. Other factors, such as dependency ratio, age, education, and profession were statistically insignificant. However, in the light of the large unexplained variation in investment expenditure, a more extensive study of the determinants of investment in pond fish culture is clearly necessary.

Summary and Policy Implications

Lack of "profitability" does not help much in explaining failure to use all ponds for fish production because all pond owners are fully aware of the profitability of fish culture. However, for the owners of unused ponds, the primary purpose for holding ponds is their other uses and not fish production.

An analysis of pond characteristics has shown that jointly owned ponds generally tend to remain unused and an analysis of factors influencing investment in fish production has indicated that joint ownership might be unfavourable for investment in ponds. Large ponds are generally found to be used for fish production and a production function analysis revealed that pond size is positively related to production of fish. Old ponds have been found to remain unused in a much higher proportion of cases than newly excavated ponds. With the present technology, size of pond and stocking rate have proved to be two important determinants of output. Price efficiency analysis and profit function analysis have demonstrated that stocking rate can be increased with advantage as it is significantly positively correlated with profit.

Pending ownership reform, two measures for bringing jointly owned ponds under fish culture deserve serious consideration. First, through a program of self-reliant village organization under *Gram Sarkar* (village government), all ponds, like all resources, of the village may be put into productive use: this had been done in the study village Brahmuttar. Second, some of the coowners may be found to take a lead in pond utilization on behalf of all other coowners who would agree to such an arrangement in return for a share in the output: this has been found to work in the study village Dholipara.

If ponds could be released from other uses, their owners might be persuaded to use them for fish culture. One such use is for drinking water, which can be replaced by tube wells. As has been pointed out (Smith 1973), this question, along with the availability of alternative water sources, such as rivers or the provision of one or two "democratic" washing–bathing tanks in each village, needs investigation.

Small size ponds may be utilized for culture of fish other than carps, which are at present the only species cultured in Bangladesh. Various species of catfish are one possibility worth trying. Old ponds that have become shallow through accumulation of soil washed down from the bank and leaves of trees standing on their banks could be cleaned and deepened with the help of cheap labour when agricultural activities slacken in the dry season. Extension work should be organized to emphasize to the owners the advantage of increasing stocking rate. Availability of fry is not much of a problem at the moment. However, to ensure that the supply of fry is adequate as pond utilization gathers momentum, research stations should be equipped to meet the demand for both traditional carp fry and fry of other suitable species for small and shallow ponds.

Enhancement of Fisheries Potential in Sri Lanka's Inland Water Bodies by Addition of Trophic Diversity

F. Ranil Senanayake and W.J. Primus Fernando[1]

The lakes and inland water bodies (tanks) of Sri Lanka are largely artificial. Although a fishery has existed in these waters for many years, the productivity has been low. The increase in productivity experienced in the recent past is seen to coincide with the introduction of an exotic species, *Tilapia mossambica*. *Tilapia* fills an empty ecological niche in the youthful tank ecosystem. Criteria for introducing fishes at another trophic level, and the use of the smaller tanks as aquaculture units in the classical sense are proposed.

Historical Background

Sri Lanka has a large number of freshwater habitats: lakes (tanks), forest pools, floodplain lakes, streams, and rivers. Although fishing has been recorded in all these habitats (Wiley 1910; Deraniyagala 1952), the major input (90%) into the inland fishery has been from the tanks. Sri Lanka does not possess any natural lakes, but it has been estimated that there are over 10 000 artificial lakes, or tanks, some of which have existed for over 1500 years (Fernando 1976). They range in size from 6500 to 0.8 ha.

Most of the tanks (93%) lie within the dry zone of the country (Fig. 1), where the annual rains are impounded in these water bodies and used for agricultural irrigation. The larger tanks are permanent whereas the smaller tanks dry out each year. The few tanks in the wet zone are relatively recent and are used for power generation. These tanks demonstrate a high degree of morphometric variability and have been divided into five classes (Fernando and Indrasena 1969) ranging from shallow and silted to deep with many valleys (Fig. 2). The fish faunas of these tanks consist largely of species from neighbouring streams and rivers, so that the different types of tanks cannot be distinguished on the basis of their fish faunas. Most of the dry zone tanks are connected to each other through the river systems. Even in the oldest tanks, there is no detectable evidence of differentiation within species to suggest any degree of isolation (Senanayake 1978).

Fernando (1965) noted the lack of typical lake fishes and concluded that the present fish fauna in these tanks were recruits from *villu* (marsh) and riverine habitats.

A fishery has existed in these tanks for a long time. A stone pillar found on the bund of the Abhayawewa (Basawakkulam tank), ascribed to Kassapa V (914–923 AD), records fishing in the tank. Similarly, a 12th century rock slab inscription by King Kirti-Nissanka-Malls prohibits fishing in the tanks of Anuradhapura. This fishery, however, may not have been highly productive. The low productivity of the tanks is mentioned in the early contemporary works on the island's fisheries (Schuster 1951; FAO 1962). The reasons advanced were that there was a lack of "desirable" herbivorous species (Amirthalingam 1949). This hypothesis may have led to a large number of exotic species being introduced into the inland waters by the Department of Fisheries (Table 1).

Introduction of Tilapia: *Unwarranted Proliferation*

The distribution patterns of the established exotics indicate that the largest populations are to be found in the tanks and reservoirs (Senanayake 1980a). This may be a reflection of the

[1]We gratefully acknowledge the assistance of Messrs W.P.P. Abeydeera, W. Gamage, R.M. Jayasena, S.A.D. Amarasena, K.D. Pieris, and S. Somachandran and, especially, the assistance of Ms Hemamala Munasinghe.

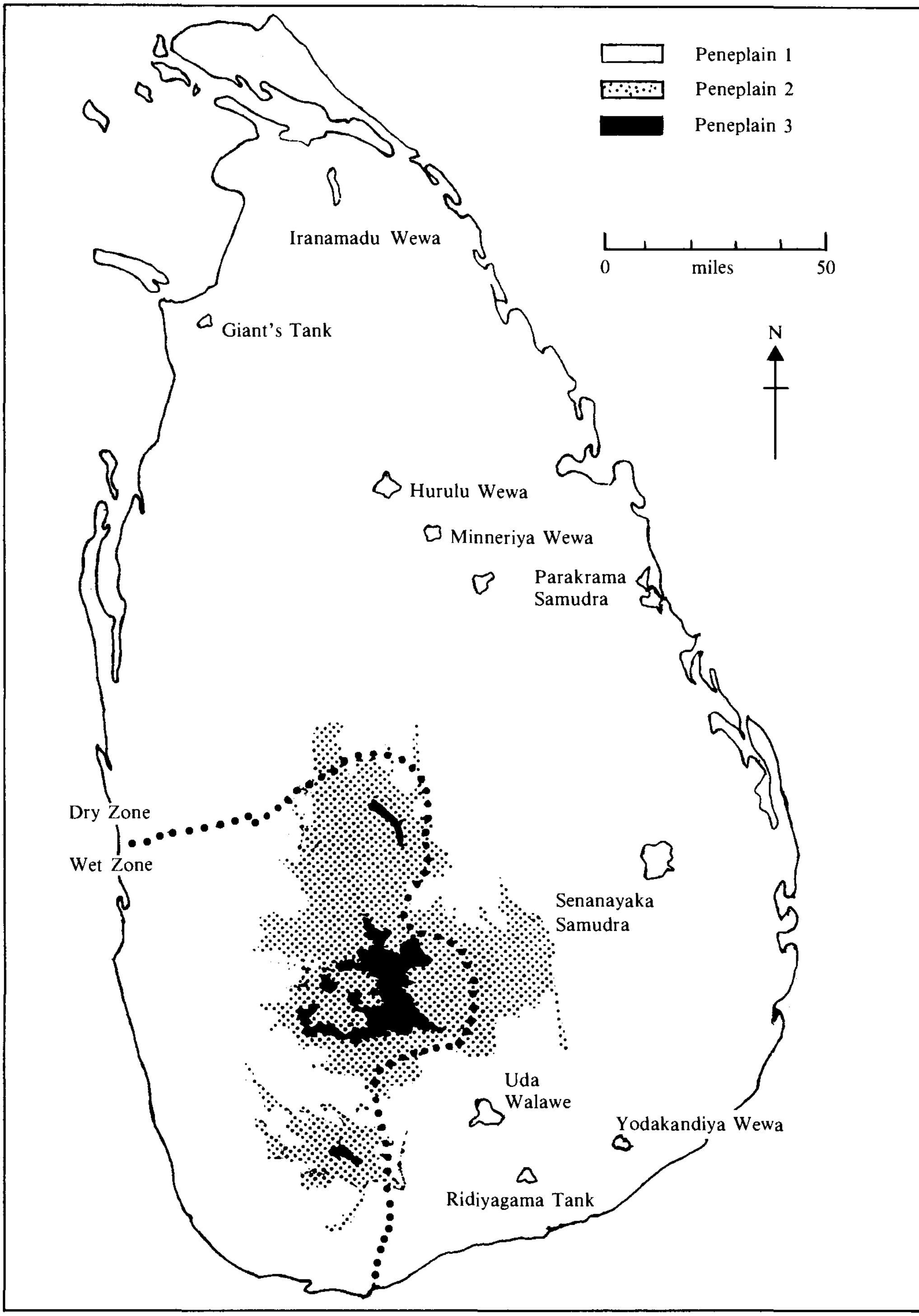

Fig. 1. Sri Lanka's climatic zones.

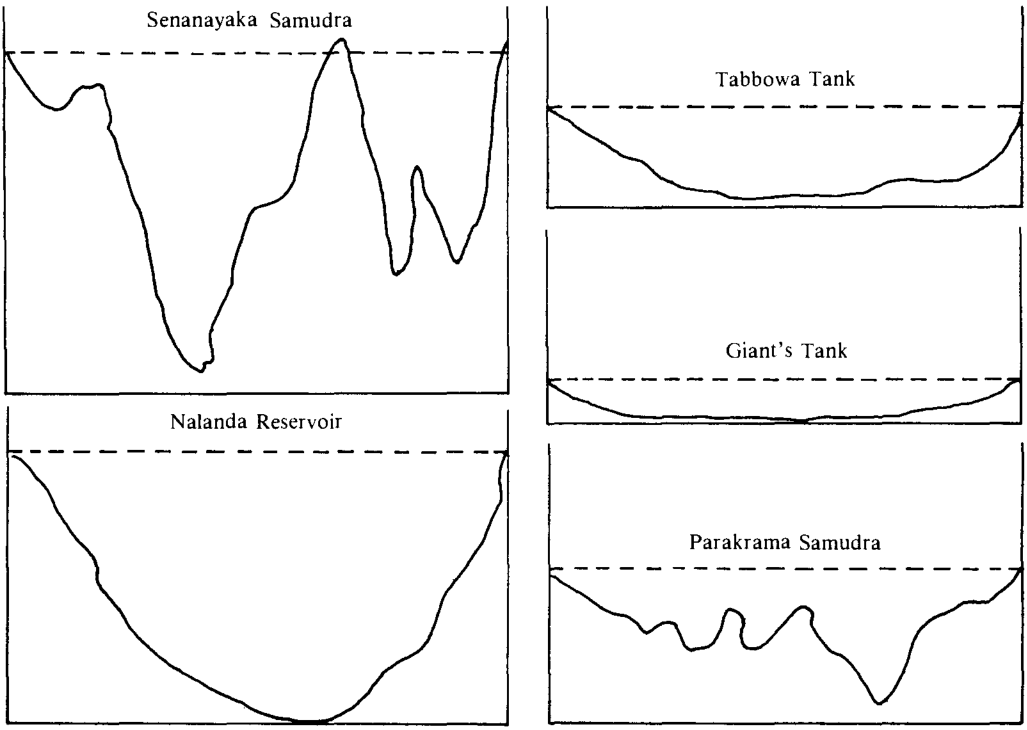

Fig. 2. Bottom profile types of the tanks of Sri Lanka (after Fernando and Indrasena 1969).

youthful nature of the tank fauna, which has no native lacustrine forms. In terms of biomass, however, only one species — *T. mossambica* — has made an impact (Fernando 1964). The rapid spread of *Tilapia* began immediately after the first few years of its introduction (1952–54). During this period, individual tanks have been reported to have gained considerably. Fernando (1980) notes that the pre-*Tilapia* catch in the Parakrama Samudra was 2.7 tons/year but that since the introduction of *Tilapia*, the catch has risen steadily to 500 tons/year in 1966, and between 800–1000 tons/year now.

The phenomenal success of *Tilapia* in Sri Lanka's inland fishery invites attention. It is not a lacustrine species and its original habitat was the coastal streams of South Africa (Moyle 1976). Therefore, it did not owe its success to being preadapted for the tank ecosystem. It is not an obligate herbivore as this species has been recorded to feed readily on crustaceans and small fish (St. Amant 1966). Its efficiency as an algivore may also be limited because it lacks the enzyme cellulase and, consequently, is unable to digest much of the algae ingested (Fryer and Iles 1972). Thus, it does not have a specialized feeding system that allows it to use those food types that are not used by the native fauna. In fact, an examination of the stomach contents of the major tank fishes demonstrates a great deal of overlap in food (Table 2). Distribution studies on the inland fishes of Sri Lanka have shown that *Tilapia* does not seem to be very successful in establishing populations in undisturbed streams (Senanayake 1980a). This evidence strengthens the hypothesis that the fish fauna of Sri Lanka's tanks are recruits from other aquatic ecosystems and, as a consequence, the tank ecosystem still has many unfilled ecological niches.

Empty Niches and Introduction of New Species

A survey of the capture fishery in 10 tanks indicates that *Tilapia* accounts for the highest proportion of biomass (generally over 70%). The other major species (Table 2) account for about 5-6% of the biomass per species when represented in the fishery.

The herbivores and omnivores listed in Table 3 occur in the same habitat as, or overlap with, *Tilapia*. These fishes are generally top- to mid-water dwellers, moving occasionally to the bottom.

Table 1. Exotic species introduced into Sri Lanka's inland waters.

Species	Year	Country of origin	Establishment[a]	Utility
Salmo gairdneri	1890	USA	–	Sport
Carsassius carassius	1890	China	+	Food
Cyprinus carpio	1890	Europe	+	Food
Osphronemus goramy	1927	Indonesia	–	Food
Poecilia reticulata	?	Tropical America	+	Mosquito control
Catla catla	1942	India	–	Food
Ctenopharyngdon idellus	1948	China	–	Food
Aristhichys nobilis	1948	China	–	Food
Hypopthalamichthya molitrix	1948	China	–	Food
Trichogaster pectoralis	1951	Malaya	+	Food
Helestoma temmincki	1951	Thailand	+	Food
Tilapia mossambica	1952	Africa	+	Food
Xiphophorus helleri	1958	Mexico	+	Accidental
Xiphophorus maculatus	1958	Mexico	+	Accidental

Source: Senanayake (1980a).
[a]Established (+) or not established (–).

Table 2. Food items present (+) in the gut contents of major food fishes, Sri Lanka.

	Detritus	Algae	Macrophytes	Crustaceans	Insecta	Oligochetes	Fishes
Tilapia mossambica	+	+	+		+	+	
Labeo dussemieri		+	+		+		
Barbus dorsalis	+	+	+		+		
Barbus sarana	+	+		+		+	+
Ophicephalus striatus				+	+		+
O. gachua kelaarti				+	+	+	+

Table 3. Species representation of the total catch in 10 tanks (% of recorded wet weight), Sri Lanka.

Name of tank	*Tilapia mossambica*	*Labeo dussemieri*	*Barbus dorsalis*	*B. sarana*	*Ophicephacus striatus*	*O. gachua kelaarti*	*Heteropneustes fossilis*	*Etroplus suratensis*	Other species
Pahalatalawa	82.6	4.2	–	1.7	6.5	2.0	–	–	3.0
Hambegamuwa	94.3	–	–	–	1.6	–	–	–	4.1
Handapana Gala	98.0	–	–	–	–	–	–	–	2.0
Parakrama Samudra	78.4	6.9	–	1.0	3.4	1.2	1.0	4.1	4.0
Udawalawe	62.4	–	5.3	12.1	10.4	–	5.3	–	4.5
Maha Kandarawa	71.3	12.1	3.4	2.1	4.1	–	4.0	–	3.0
Ridiyagama	71.3	2.0	4.2	3.5	2.1	–	4.7	4.1	8.1
Giant's Tank	82.5	–	4.5	3.1	2.0	–	1.0	2.1	4.8
Senanayake Samudra	75.7	–	5.3	4.6	3.3	–	2.0	1.0	8.1

The predators, however, occupy a very different habitat. *Ophicephalus striatus* favours weeds and vegetation, *O. gachua* occupies a similar habitat but favours shallow water. *Heteropneustes fossilis* lives exclusively on, or close to, the bottom. The absence of a mid-water predator is striking and, again, may reflect the evolutionary youth of the tank ecosystem.

The possibility of introducing predatory fish such as *Notopterus* had been suggested (Fernando and Indrasena 1969), but the negative impact on the existing fauna by exotic predators is a possibility.

In Florida, the introduction of exotic predators has threatened many native species (Lachner et al. 1970). The introduction of the exotic predator *Chiclosoma occelatum* into Lake Getun in Panama resulted in the loss of the established fishery in that lake.

The basic problem with exotic predators is that, given the right conditions, they may expand their population to numbers large enough to affect the native fishery adversely. This may happen by "prey depletion" when the large numbers of predators feed on their prey at a greater rate than the prey species can replenish stocks. In such a case, the prey population will decline and the predator population will then crash due to a lack of prey. The overall effect is a major collapse of the fishery. The ideal predator for an introduction program would be a species that has a limited capacity to reproduce. The idea, however, is impractical in the sense that if a fish can reproduce in a given body of water, there is always the potential of a population explosion. Another possibility for the selection of an exotic predator would be a species with a physiological inability to breed in the new situation. This would entail regular stocking but would be free of the problems of overbreeding and negative impact on the native species.

Choosing the Right Species: Red Snapper and Estuarine Perch

One group of fishes that would satisfy the criteria set out above is marine predators. Such predators should be obligate spawners in saline water so that their larvae are physiologically incapable of surviving in fresh water.

The most promising species that fulfil these requirements were found to be the red snapper (*Lutjanus argentemaculatus*) and the estuarine perch (*Lates calcarifer*). Both species breed in the sea but enter estuaries as larvae. They grow to large sizes in the estuaries and are capable of tolerating a wide fluctuation in the salinity content of the water. *Lates calcarifer* has a long history of brackish aquaculture in Bangladesh and records indicate a survival rate of 90% in pond culture with a growth from larva to 0.6 kg fish in 7 weeks (Bardach et al. 1972). Both species have been recorded to travel up rivers (Munroe 1965).

Initial trials with both *L. argentemaculatus* and *L. calcarifer* indicate that a sudden or quick transfer from full strength sea water to fresh water may result in over 80% mortality. However, if the transfer from full strength sea water or lagoon water to fresh water is done as a graded process a survival rate of over 90% can be achieved (Table 4). A dilution rate of 10% per day achieves the desired goal of the best survival rate in the shortest period of time. It should be noted that there are further requirements needed in the transfer. The fish may become prone to fungal infection when the salt concentration has dropped to 40% of the initial concentration and the addition of a fungicide at this stage has proved useful in laboratory trials.

Enhancement of the Fishery's Potential and Other Benefits

The introduction of acclimatized fingerlings

Table 4. Survival rates[a] of 3-cm fingerlings of Lutjanus argentemaculatus *and* Lates calcarifer *at different dilution rates.*

Dilution rate (%)	*L. argentemaculatus*	*L. calcarifer*
0 (control)	98	98
5	98	98
10	96	96
15	83	83
20	73	75

[a]Survival rates (%) based on 20 samples for *L. argentemaculatus* and 25 for *L. calcarifer*.

of *L. calcarifer* and *L. argentemaculatus* into the larger tanks will add to their trophic diversity. It will also bring a high value fish into the tank fishery. At present, both species command a market price six to seven times that of *Tilapia*. These species will also contribute to the commercial value of the larger tanks by making them sport-fishing areas.

The fishery of the smaller annual village tanks can also benefit by the introduction of these acclimatized predators. These tanks are annual ponds amenable to aquaculture but have not been utilized as such. With the introduction of *Tilapia*, these tanks may be used for annual stocking and harvesting but the problem of overpopulation must be contended with. Overpopulation and subsequent stunting of the fish has been recognized as one of the great drawbacks to *Tilapia* culture (Bardach et al. 1972) because it leads to a large biomass of fish of low market value. For instance, in Kivu Province in Zaire, yields of 4325 kg/ha were recorded in *Tilapia* culture ponds. However, 70% of such yields consisted of fish less than 15 cm in size. The addition of predators such as *L. calcarifer* or *L. argentemaculatus* can convert much of the smaller fish into high value biomass.

Any program using acclimatized predators will require a source of supply for the introductions. This requirement may be utilized to create a new occupation in the coastal zone. Such a job will entail the collection of the fry of the predators from estuarine situations and their acclimatization to fresh water. The acclimatized fish could then be sold as seed to the government agency in charge of introductions or even to private fish farmers. The fry are now captured in the course of the *Mas Athu* fishery (Senanayake 1980b) and in the *Kraal* fishery and are treated as trash fish with no commercial value. Development of a market for the predator fry could also increase the catch value of these fisheries.

Synthesis

Small-Scale Fisheries in Asia: Summary and Conclusions

Theodore Panayotou

The studies in this volume come against a background of widely held presumptions and suppositions about small-scale fisheries:

- Small-scale fishermen are thought to be generally poor — poorer than other comparable socioeconomic groups — and as such to deserve generous government assistance.
- Mechanical and modernized vessels are believed to be always more productive and more profitable than nonmechanized traditional units and therefore governments should subsidize the purchase of modern mechanized vessels.
- Coastal fisheries are perceived as "overcrowded" with labour and starved of capital and fuel and, therefore, a policy of cheap (subsidized) capital and fuel is seen as a means to improve their performance.
- Fishermen are seen to face capital constraints and it is inferred that subsidized credit would improve their productivity and income.
- Religion, caste, local power structures, and other impediments to the free movement of labour and capital are regarded as detrimental to fisheries development.
- Fish traders and middlemen are seen as unscrupulous exploiters of fishermen and should be done away with.

To cure all these ills, mechanization subsidies, concessionary credit, fishermen's cooperatives, state marketing agencies, and other fisheries development measures have long been considered as panaceas for the problems of small-scale fisheries.

Treating these and other similar presumptions as hypotheses, the authors surveyed thousands of fishermen in five Asian countries and employed a wide range of analytical tools to test them. The evidence suggests that these presumptions have no general validity, but they could be right or wrong depending on the circumstances.

First of all, it is evident that the coastal fishermen are neither a clear-cut nor a homogeneous group: they come from diverse sociocultural backgrounds, operate a variety of gears to exploit a nonuniformly distributed resource, and engage, to varying degrees, in nonfishing activities to supplement their fishing incomes. Their dependence on fishing is a function of both the profitability of fishing and the availability of alternative employment opportunities. This feature of coastal fisheries suggests that, in each country, efforts should be made to identify the particular groups of fishermen who are in need of assistance, and to direct the limited government funds toward these groups rather than to the fishery sector or the small-scale fishery subsector as a whole.

In all countries studied, it was found that coastal, small-scale, or municipal fishermen are on the average no worse off (and in Sri Lanka and Bangladesh markedly better off) than the average rural citizen of the respective country. It is when one disaggregates the small-scale fishery into fishing gears and locations that it is apparent that many, and in some cases most, fishermen earn incomes below the national rural average and even below what one can reasonably consider as their opportunity costs. These are not always the smaller-scale units or the nonmechanized traditional craft. In the Philippines, motorized boats were found to earn less, on the average, than nonmotorized ones and, in Thailand, trawlers in Chumporn were earning less than non-powered gear in Pang Nga. High incomes are earned by those gears that are able to earn resource rents through territorial fishing rights (e.g., beach seines in Sri Lanka) or efficiency-and-flexibility rents by investing promptly in new technology and skills (e.g., purse seines in Thailand). Low incomes are earned by immobile fishermen operating inflexible gears in crowded open-access fisheries.

Institutional and sociocultural constraints, such as caste and to a lesser extent religious prohibitions, that result in essentially customary fishing rights, whether vested in communities or local power structures, have helped rather than harmed the performance of South Asian fisheries, distributional considerations aside, in the sense of preventing the overcapitalization and overfishing experienced by Southeast Asia. Demolishing these traditional barriers to entry without effective regulation of effort, which could be prohibitively costly, may lower rather than raise social welfare. What is needed is recognition of the existence of these rights and corrective measures to improve their functioning and distribution of benefits.

The most significant overall determinants of catch were location (resource abundance), type of gear, and managerial ability (skill). Increasing the size and power of vessel or reducing the mesh size of net does not always lead to an increase in catch; this depends on the type of gear and the abundance of the resource. The individual fisherman can increase his catch, and perhaps profits, by enlarging his vessel, provided that other fishermen are not doing the same. The logic of many motorization subsidies derives from the observation that the first few who motorize improve their lot at the expense of those who do not. However, if all are assisted to motorize, at whose expense would they all improve their lot? Unless there is some unexploited resource deeper or further off shore that becomes accessible through mechanization, the solution to poverty in the fishery should be found outside the fishery.

When relative prices and hence profitability were considered, many gear groups in Thailand were found to be using "too much" fuel and "too little" labour, contrary to the common belief. Therefore, boat owners could increase their profits by simply substituting labour power for engine power, within limits of course. Considering the high cost of imported fuel (especially in terms of scarce foreign exchange) and the abundance of cheap local labour, it would be beneficial from the society's point of view not only in Thailand but also in Sri Lanka and the Philippines to encourage the use of more labour and less fuel through appropriate incentives. The Malaysian fishery could profitably use both more fuel and more labour, whereas in Bangladesh labour is used beyond its privately optimum level, but not necessarily up to its social optimum.

It is true that small-scale fishermen face capital constraints — almost by definition — and this is often why they use inputs below their efficiency levels, but this does not imply that providing them all with subsidized credit would improve their situation. Fishing investment would certainly rise and fishing technology would improve, but what happens to the catch depends on the state of the resource and what happens to income depends on both catch and cost changes. If the catch increases minimally while fuel and maintenance costs rise substantially, income might fall rather than rise and not only would fishermen be unable to pay their loans but also they would need additional credit to meet their increased expenses. The Philippine experience is a case in point.

What about marketing? Is it true that the middlemen exploit the fishermen? If not, then what explains the large marketing margins? Again, the answer depends on the particular case under consideration. In Sri Lanka, no evidence of price collusion or monopolistic practices was found; the marketing system was fairly competitive and the large marketing margins could be explained partly by the high marketing costs (transport, credit, and risk) and partly by disequilibrium rents in the opening of new markets (e.g., for the interior or for export). In contrast, in the Philippines, there was some evidence of oligopolistic practices but these do not necessarily justify a government takeover of the marketing function if less severe measures would improve the existing system's competitiveness and efficiency.

The findings of this volume suggest areas in which the efficiency and profitability of fishing, and hence the well-being of the fishermen, could be improved through deliberate policies to upgrade management and skills, to convert less profitable types of gears into more profitable ones, to encourage the substitution of more-productive or less-costly inputs for the less-productive or more-costly ones, and to increase the competitiveness and efficiency of the marketing system.

However, apart from promoting efficiency and full utilization of any underutilized resources, the potential for further development of capture fisheries is strictly limited by the size of the resource. In Southeast Asia, fish resources are already overfished and in need of recovery if they are to yield their full potential. Not only does the scope for further fisheries development appear to be strictly limited but also the success of any possible fisheries development would be determined by management measures taken concurrently with development. Otherwise, fisheries development implemented in the context of an open-access fishery would lead to further entry, intensified overfishing, and ultimate frustration of the government efforts to improve the socioeconomic conditions of small-scale fishermen.

Fisheries management can make a dual contribution toward the improvement of income levels of small-scale fishermen:

- By limiting entry into the coastal fishery, it would help consolidate any possible gains from fishery development and
- By effectively prohibiting the operation of the large-scale fishery (particularly trawlers) in the coastal waters, it would enlarge the effective resource base of the small-scale fishery.

The obstacles to effective fisheries management in developing countries should not be underestimated, however. It may not be politically or administratively feasible to effectively limit the access to the coastal fishery either from the land, by people with no better alternatives, or from the sea, by trawlers in search of high-value species such as prawns.

In light of the limits to marine fisheries development and the difficulties of fisheries management, the government objectives for increasing fish production and improving the income levels of small-scale fishermen could be best achieved through land-based development, particularly promotion of coastal aquaculture and revival of inland fisheries. Our findings offer support to development efforts away from the marine fishery, except in the case of Bangladesh and the offshore resources of Sri Lanka, toward alternative employment opportunities for coastal fishermen and alternative sources of fish production.

The various departments of fisheries would need to be empowered with additional authority, including enforcement capability, as well as an additional development budget, if they are expected to deal effectively with the problems of a depressed coastal fishery and falling fish production. In the meanwhile, certain parts of the coastal fishery, such as that of Visayas in the Philippines and of Nakhon Si Thammarat in Thailand, are in urgent need of assistance because income levels of fishermen in these areas fall short of the government-defined poverty line. It is not likely that upgrading fishing gear would do much to improve the situation unless additional fishery resources are allocated and trawlers can be kept out of the coastal waters effectively.

The conditions for brackish and other coastal aquaculture appear to exist but extension of technology, basic infrastructure, and institutional arrangements would be necessary. Because much of the coastal area and brackish waters suitable for aquaculture are untitled common or public property, appropriate institutional arrangements would be necessary to establish the security of tenure necessary for long-term investments in aquaculture. A lesson learned from the study of household ponds in Bangladesh and of disused mining ponds in Malaysia is that multiple ownership and insecurity of tenure are detrimental to the utilization of even existing ponds for fish culture. Excavation of new ponds and construction of fish pens require considerable investment, which would not be forthcoming unless the returns are high enough and secure over the life of the investment. Because of the infant stage of aquaculture, there is considerable scope for government intervention to improve technology and to provide infrastructure, including fry hatcheries.

At the same time, the possibility of developing supplemental nonfishing activities should be actively explored in cooperation with other government agencies such as those responsible for agriculture, coastal development, tourism, and the environment. What particular projects would be economically feasible and socially advisable cannot be determined a priori; they would depend on the specific conditions and resources of each fishing community and, as such, they would require on-the-spot, case-by-case study.

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